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Utilizing Metabolites from *Streptomyces* in Plant Pathogenic Fungi Control

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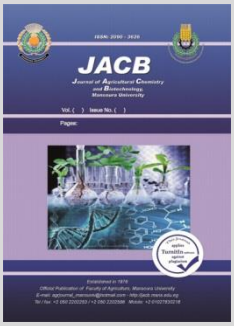

ABSTRACT

Most *Streptomyces* species are well known to be effective as biological control microorganisms against numerous pathogens; hence, *Streptomyces* genus is best described as the foundation of all utilized antibiotics on planet earth. Antibiotics are utilized in a variety of contexts, including agriculture and medicine. Authors of this work have effectively isolated *Streptomyces* species from soil samples gathered across several Egyptian governorates. The antimicrobial activity of *Streptomyces* isolates against strains of several phytopathogenic fungi, including *Alternaria sesame*, *Fusarium oxysporum*, and *Rhizoctonia solani*, was assessed following collection, isolation, and molecular identification. From all *Streptomyces* isolates investigated, antifungal assessment results demonstrated that *BF2*, *BF16* and *GH11* were the most effective isolates against fungi. In this study, authors utilized transmission electron microscope, traditional morphological and advanced molecular procedures to better characterize *Streptomyces*' antimicrobial properties. Results proved that isolates, *BF2*, *BF16* and *GH11*, belong to *Streptomyces* genus. 16S rRNA nucleotide sequence from *BF2*, *BF16* and *GH11* were deposited to the National Center for Biotechnology Information (NCBI) and assigned accession numbers; *BF2* (ON130145), *BF16* (ON130199) and *GH11* (ON130172), respectively. Based on 16S ribosomal Ribonucleic Acid (rRNA) gene sequencing, data revealed that isolates *BF2*, *BF16* and *GH11* are affiliated with *Streptomyces vietnamensis*, *S. antibioticus* and *S. mediolani*, respectively. This work supports investigations into novel biocontrol strategies for phytopathogenic species that are just as successful as conventional fungicides. These strategies are believed to generate interest worldwide since they lessen the use of pesticides in agriculture while also having a favorable environmental impact.

Keywords: *biological control, Streptomyces, phyto pathogens, 16S rRNA, NCBI*

INTRODUCTION

Plant pathogens have historically resulted in large-scale economic losses around the world, having a particularly detrimental effect on the economies of third-world countries and even famines during each cropping cycle, (Ruth *et al*, 2023). While several microbes, including fungi, bacteria, viruses, and viroids, are thought to be the primary cause of phyto diseases, the bulk of plant diseases are attributed to fungi. Due to farmers reliance on chemical fungicides in controlling phytopathogenic fungi (Rammali *et al*, 2022; Ruth *et al*, 2023), overuse, misuse of fungicides and mutations in the pathogens' genetic background [which lead to changes in Pathogen Associated Molecular Patterns (PAMPs)], have contributed to an increased rate of pathogenic fungi with evolved resistance to chemical fungicides.

Global concerns have been expressed about pesticide-resistant pathogens and agrochemical pollution in the environment. Therefore, there is a need to carefully consider and create new methods that are both secure and efficient for managing pathogenic fungi. Plant pathogens treatment with secondary metabolites produced by some microbes, preserving antimicrobial properties, have demonstrated promising role in agricultural management, (Singh *et al*, 2018). Taxonomically, *Streptomyces* is best described as an order, Streptomycetales, which falls under Actinobacteria class. These ubiquitous gram-positive bacteria preserve high guanine and cytosine contents in their Deoxyribonucleic Acid (DNA) with a distinctive filamentous morphology, (Dhakal *et al*, 2017). Since *Streptomyces* produces metabolites that have proven to be important bioactive compounds, it is considered to be the best-studied member in Actinobacteria. Such compounds have shown anticancer, antifungal, antibacterial and immunosuppressive properties, which have been utilized in extensive biotechnological and industrial purposes all over the globe, especially antibiotic synthesis, (Madigan and Martinko, 2007; Aftab *et al*, 2015; Khushboo *et al*, 2022). This study investigated the antifungal effects of numerous *Streptomyces* isolates that were collected from different Egyptian soils against commercially significant pathogenic fungi.

MATERIALS AND METHODS

Bacterial strains

Our research team was able to isolate *BF2, BF16 and GH11* isolates successfully, utilizing serial dilution technique reported by Yekkour *et al*, 2012 and Njoroge *et al*, 2018, by our research team from Egyptian agricultural soils.

Medium preparation and isolates conformation

Streptomyces isolates were plated on inorganic salt starch agar (ISSA) solid medium plates before visible colonies peaked. Five days after inoculation at 28 °C, the colonies were purified by streaking on ISSA solid medium plates, according to Hossain and Rahman, 2014. Isolates of *Streptomyces* were successfully validated by growing under optimal temperature, 30 °C, on Yeast Malt Agar (ISP Medium No. 2), ISP Medium No. 3, ISP Medium No. 4 and ISP Medium No. 5 as detailed in Yekkour *et al*, 2012. After inoculation, we tracked the bacterial growth for seven, fourteen, and twenty-one days. In order to verify the purity of

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the isolates, we relied on characteristics specific to *Streptomyces* including, but not limited to, mycelium distinct features such as reverse color assessments and presence of the soluble dye in the mycelium as described by Szabo and Marton, 1964; Pridham, 1965; Sharma *et al*, 2014.

Light and Transmission Electron Microscope (TEM) inspections

The Cover-slip method, detailed by Bennett *et al*, 2018, was used for visualization of spores' arrangement on mycelium under high power objective in light. Magnification power used was 400X. To examine spores, carbon-coated grids were placed in mature aerial growth zones. Spores were visualized using a JEOL-JEM 1010 TEM set at 80 kV, operated at the Electron Microscope Unit at Mansoura University. The morphological characteristics were reported in the Results section

Antifungal bioassay

Using the dual-inoculation method, three plant pathogenic fungi—*Alternaria sesame,* which infects sesame, *Fusarium oxysporum,* which is considered the main cause of wilt in tomato, cotton and vegetable crops in Egypt and *Rhizoctonia solani,* the main cause of root rot in vegetable crops in Egypt—were utilized as tester species to evaluate the antifungal activities of *Streptomyces*. Tester fungi were grown on Potato Dextrose Agar solid medium. Next, an 8 mm disc plug was placed in the center of the PDA medium, and the growth of *Streptomyces* was measured concurrently. The disc plug was loaded with filtrate from liquid medium inoculated with *Streptomyces* isolates under investigation. Consequently, the antifungal activity surrounding the discs was assessed, according to Njoroge *et al*, 2018. Discs, 6 mm in diameter, were loaded with bacterial colonies and cut out from casein glycerol medium using a cork borer. Discs were then transferred, aseptically, into 250 ml Erlenmeyer flasks. Inoculated flasks were kept under shaking condition, 120 rpm at 30 ±2 °C, for twelve days according to Shahid *et al*, 2021. Utilizing ultra centrifugation, bacterial cells formed pellets upon centrifugation of the broth culture for twenty-two minutes at 4000 rpm. Supernatant was later discarded from bacterial cells using 0.2 mm pore size membrane filter. As a result, filtrate contained antibiotic compounds, as described by Njoroge *et al*, 2018.

Antifungal activity of supernatant

Culture filtrate's antifungal activity was assessed using paper-disc diffusion method. *Fusarium oxysporum* and *Alternaria sesame* spores' suspension, in the concentration of 100 spores/ml, was produced and spread on PDA medium plates to determine its antifungal properties, according to **Njoroge *et al*, 2018.** An 8 mm disc, loaded with *Rhizoctonia solani* mycelium, was placed on PDA plate and incubated at 26 °C for seven days. Then, 4 ml of sterile distilled H_2O was added to the cultured PDA. Then, swap was used to mix mycelium with water to form a suspension. Then, 0.5 ml of the suspension was transferred to a new PDA plate and swap was utilized to spread and distribute the suspension on the medium surface. Whatman® paper discs (containing culture filtrate) were placed in the newly cultured PDA plate for antifungal activity assessment.

Separation of antimicrobial bioactive metabolites:

To recover compounds preserving antimicrobial properties within liquid secretions, solvent extraction technique, detailed in Maiti *et al*, 2020; Mothana *et al*, 2022, took place as follows: 1:1 v/v Ethyl ethanoate was then mixed with filtrate (in a 50 ml. Falcon® tubes) and kept for 60 min. on a mechanical orbital shaker, which was previously set at 130 rpm. Upon completion, falcon tubes were submerged in hot water-bath treatment (80-90 °C) to evaporate Ethyl acetate and precipitate compounds preserving antimicrobial properties, from the aqueous phase, in accordance with Njoroge *et al*, 2018. 10 mg were dissolved in 1 ml of Dimethylsulfoxide (DMSO) as detailed by Arasu *et al*, 2009. Then, 6 mm paper disks, loaded with DMSO containing antibiotics, were used for further analyses. Typically, growth-inhibition zones within PDA medium plates, cultured with tester pathogens, showed up upon adding paper disks loaded with fungal spore solution, in comparison to disks loaded only with DMSO, without fungal residues, as a control.

***Gas Chromatography-Mass Spectrometry (GC-MS) analysis*:**

Compounds in the supernatant resulted from liquid medium, inoculated with *Streptomyces* isolates under investigation, were identified through GC-MS instrument, according to Mirsonbol *et al*, 2022. Mass spectrum was reported utilizing Thermo Fisher Scientific™ TRACE 1310® Gas Chromatograph attached to ISQ™ LT single quadrupole Mass Spectrometer. The column utilized was a DB5-MS, 30 m; 0.25 mm ID (J&W Scientific). Ionization mode: EI, while Ionization voltage was set at 70 ev and temperature program was set as initial temperature at 40 ºC (for 3 min.) and then increased to 280 ºC (for 5 min.) at 5 ºC/min. 290 ºC (for 1 min.) at 7.5 ºC/min. Detector temperature: 300 ºC, while Injector temperature was set at 200 ºC. Helium was used as a carrier gas and flow rate was set at 1 ml/min. Results of mass spectra were aligned against searched library Wiley and Nist Mass Spectral® Data Base.

Scrutinizing soil for streptomyces

Agricultural soils, collected by our research team from various governorates in Egypt, representing wheat, acid lime, beet and broad bean, formed *Streptomyces* source in the current research. Upon collection, soil samples were air-dried in accordance with Antido, and Climacosa, 2022.

Molecular identification, sequencing, and computational analysis of Streptomyces isolates

DNA from bacteria was isolated in accordance with Babadi *et al*, 2022. Polymerase Chain Reaction (PCR) amplification took place in a total volume of 50 µl. The reaction consists of 1.5 mM $MgCl_2$, 1 unit of Taq enzyme, 2.5 mM dNTPs, 25 µM of forward and reverse primers and 25 ng of template DNA. PCR amplification took place in a Perkin-Elmer PCR System (PE Applied Biosystems). DNA template was denatured for 5 min, then a total number of 32 cycles were applied as follow: 30 sec at 94 °C (denaturation), 30 sec at 45 °C (annealing), 1 min at 72 °C (elongation) and finally, an extension phase was carried out at 72 °C for 10 min (last cycle). Resulted DNA amplicons, along with 100 bp DNA ladder as a standard molecular-weight size marker, were electrophorized in a 1.5% agarose gel in 1X TBE buffer at 95 V. for 45 min. Upon completion, the agarose gel was stained with 0.5 ug/ml ethidium bromide for visualization under UV light using gel documentation System Gel Doc TM 2000 from BIO-RAD.

Forward primer 5′- AGAGTTTGATCCTGGCTAG -3
′Reverse primer 5′- GGTTACCTTGTTACGACTT -3′
Fragment size: 1500 bp.

Amplicons, resulting from PCR reaction, were purified using the EZ-10 Spin Column® Cleanup Miniprep Kit and purified DNA was stored at -20 °C for further analysis, according to the manufacturer's instructions.

The PRISM® 3730XL instrument (Applied Biosystems) was used to sequence PCR purified DNA fragments

utilizing BigDye™ Terminator v3.1 cycle sequencing kit, in accordance with the manufacturer's instructions. To create sequencing pass on each of the DNA template, 16S forward primer was used. Labeled DNA fragments were separated from the unincorporated precursors, such as promoters and terminators, using ethanol precipitation technique. Samples were then resuspended in ddH_2O for further sequencing. DNA sequences were then analyzed using the BLAST tool available at (http://www.ncbi.nlm.nih.gov/BLAST).

Statistical analysis

Statistical analysis was conducted using analysis of variance (ANOVA), following the guidelines provided by Gomez and Gomez (1984). At a significant threshold of 5%, the mean values were compared. Both Excel® Add-ins and XLSTAT® statistical package software (ver. 2019.1) were used for all statistical analyses.

RESULTS AND DISCUSSION

Results

Streptomyces isolates' antifungal properties

Dual-culture bioassay results of three *Streptomyces* isolates (*BF2*, *BF16* and *GH11*) have shown that these isolates preserved the highest antifungal properties in response to *Rhizoctonia solani*, *Alternaria sesame* and *Fusarium oxysporum* treatment as shown in Fig. 1.

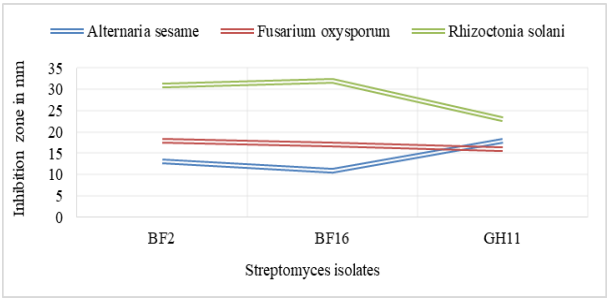

Fig. 1. Antifungal properties of *Streptomyces* isolates against phytopathogenic fungi utilizing Dual-culture technique.

Ethyl acetate played a major role in separating numerous antifungal substances from broth medium filtrate cultivated with *Strepromyces*. Fungal testers (representing *Rhizoctonia solani*, *Alternaria sesame* and *Fusarium oxysporum*) were treated with previously mentioned filtrate have shown that isolates *BF2*, *BF16* and *GH11* inhibited fungal pathogens' growth as shown in Fig. 2 and Tab. 1.

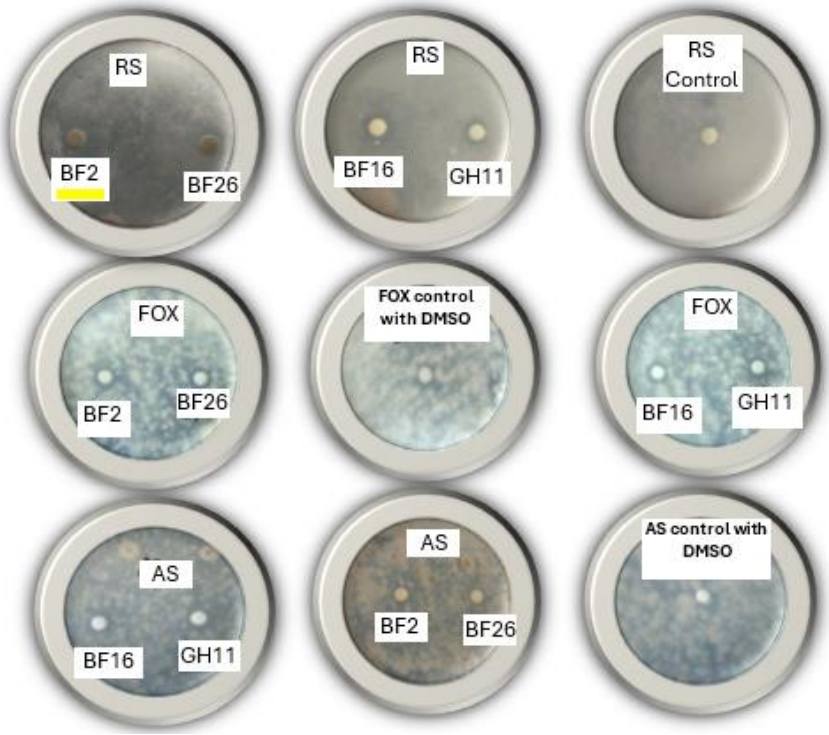

Fig. 2. Antimicrobial properties of Streptomyces isolates BF2, BF16 and GH11 in response to Alternaria sesame [AS], Fusarium oxysporum [Fox] and Rhizoctonia solani [RS] treatment.

Tab. 1. Antimicrobial properties of *Streptomyces* isolates *BF2*, *BF16* and *GH11* in response to *Alternaria sesame* [AS], *Fusarium oxysporum* [Fox] and *Rhizoctonia solani* [RS] treatment, utilizing paper disk diffusion method.

Fungal tester *Streptomyces* isolates	AS	FOX	RS
BF2	11.6 a	10.3 a	9 b
BF16	15 a	9.6 a	12 a
GH11	11.3 b	9.6 a	11.6 a
LSD ($p < 0.05$):	3.6	1.4	2.4

It is important to note that the average diameter of the zone of inhibition in the Dual-culture bioassay methodology varied from 10 to 32 mm, whereas the average diameter of the zone of inhibition in the paper disk diffusion method ranged from 9 to 15 mm. As a result, isolates *BF2*, *BF16*, and *GH11* maintained strong antifungal qualities in phytopathogenic fungus control.

Cultural and morphological characterization of isolated Streptomyces

Streptomyces isolates under study produced characteristic, powdery surface dense colonies, on solid media. Such characteristic highly suggests spores' formation. The cover-slip method was used to study aerial mycelium features. The rectus type was represented by isolate *BF2* sporophore, whereas the flexibilis type was well represented by isolates *BF16* and *GH11* (Fig. 3). Spores' surfaces TEM images indicate that they are smooth. Fig. 3 lists and describes the shapes of the spore surface and sporophores, respectively.

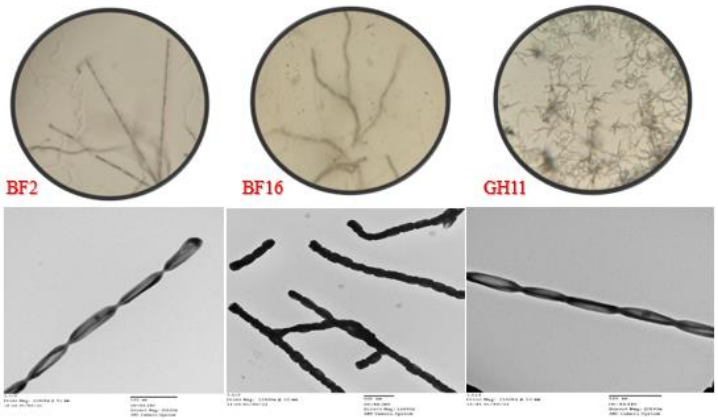

Fig. 3. Spore surface under light microscope. Power magnification used is 400X (upper images in circles) and sporophores shapes under TEM (lower images in rectangles).

Tab. 2 .Spore surface and sporophores shapes.

Streptomyces isolates	Surface shape	Sporophore shape
BF2	Smooth	Rectus
BF16	Smooth	Flexibilis
GH11	Smooth	Flexibilis

Based on morphological analysis, all isolates under investigation are believed to be members of *Streptomyces* genera that come in different color varieties, according to Bergey's Manual of Systematic Bacteriology, (Bergey and Hensyl, 1994), as illustrated in Tab. 3.

Tab. 3. Morphological characteristics of *Streptomyces* isolates grown on various media types.

	Streptomyces isolates					
	BF2		*BF16*		*GH11*	
Characteristics / **Media type**	**Aerial mycelium color**	**Substrate mycelium color**	**Aerial mycelium color**	**Substrate mycelium color**	**Aerial mycelium color**	**Substrate mycelium color**
ISP2	Light gray	Yellow-brown	Light gray	Yellow-brown	Dull yellow	Yellow-brown
ISP3	Light gray	Creamy	Light gray	Creamy	Dull yellow	Yellow-brown
ISP4	Light gray	Yellow-brown	Light gray	Yellow-brown	Dull yellow	Yellow-brown
ISP5	Light gray	Yellow-brown	Light gray	Yellow-brown	Dull yellow	Yellow-brown

Molecular analysis of Streptomyces isolates

Description of *Streptomyces* isolates showing significant antifungal properties was accomplished using 16S rRNA gene amplification, which resulted in a 1.5 kb amplicon. Phylogenetic tree results indicated that *Streptomyces* isolate, coded *BF2*, belonged to *Streptomyces vietnamensis,* while isolate *BF16* belonged to *Streptomyces antibioticus* and isolate *GH11* belonged to *Streptomyces mediolani* (Fig. 4).

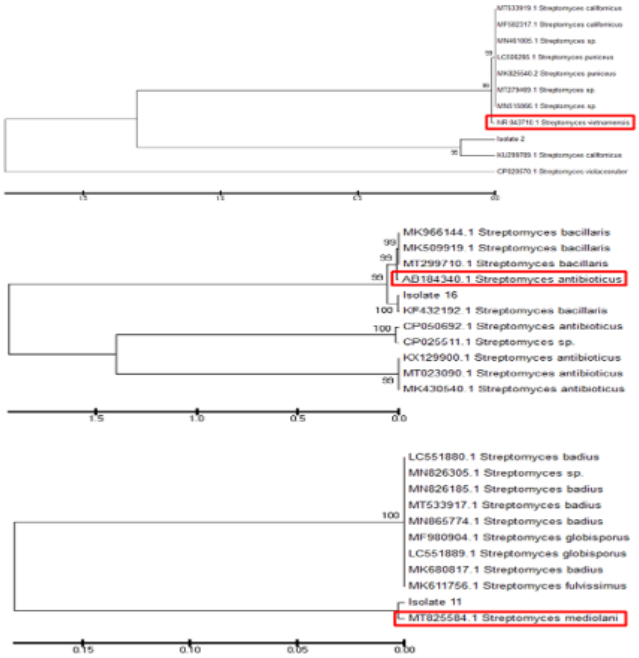

Fig. 4. Phylogenetic tree of 16S rRNA genes nucleotide sequences from isolates *S. vietnamensis*, *S. antibioticus* and *S. mediolani*, respectively.

Discussions

Gas Chromatography-Mass Spectrometry (GC-MS) analysis

Results demonstrated that *Streptomyces mediolani* encompasses one hundred and thirteen components, while *Streptomyces vietnamensis* and *Streptomyces antibioticus* encompass eighty-five and fifty-four components, respectively. The majority of these components preserved antimicrobial properties such as; 1) Oleic acid $C_{18}H_{34}O_2$, preserved fungicides, herbicides, insecticides and plant growth regulators; 2) Hexadecanoic Acid and 2,3-

Dihydroxypropyl Ester $C_{19}H_{38}O_4$, preserved antiviral properties. Compounds resulted from the analysis were defined and their properties were retrieved and characterized from https://pubchem.ncbi.nlm.nih.gov. Compounds of importance to our investigation are listed in Fig. 5 and Tab. 4.

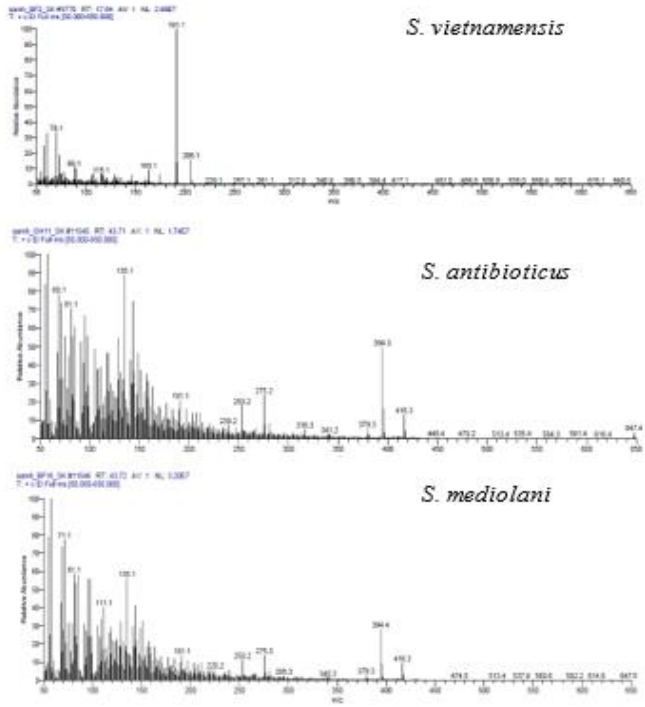

Fig. 5. ***S. vietnamensis, S. antibioticus*** **and** ***S. mediolani*** **metabolites' peaks resulted from GS-MS instrument.**

Tab. 4. ***S. vietnamensis, S. antibioticus*** **and** ***S. mediolani*** **metabolites' molecular formula and characteristics.**

Streptomyces vietnamensis			***Streptomyces antibioticus***			***Streptomyces mediolani***		
Component	**Molecular formula**	**Characteristics**	**Component**	**Molecular formula**	**Characteristics**	**Component**	**Molecular formula**	**Characteristics**
Gibberellic acid	$C_{19}H_{22}O_6$	Plant growth regulators	Dexibuprofen	$C_{13}H_{18}O_2$	Anti-inflammatory and antirheumatic products (Human Drugs)	Gibberellic acid	$C_{19}H_{22}O_6$	Plant growth regulators
Ethonafide	$C_{22}H_{22}N_2O_3$	Antibacterial agents - Antineoplastic agents	9,10 Dimethyl anthracene	C16H14	Laboratory chemicals. manufacture of substances.	Oleic Acid	$C_{18}H_{34}O_2$	Fungicides-Acaricides. Herbicides. Insecticides. Plant growth regulators
Phenanthrene	$C_{14}H_{10}$	Synthesis of drugs, biochemical research	Dipropyl isocinchomeronate	$C_{13}H_{17}NO_4$	Insecticide- antimicrobial			
Tetradecanoic acid	$C_{14}H_{28}O_2$	The antitumor activity	Corticosterone	$C_{21}H_{30}O_4$	Anti-Inflammatory agents			
Cyclandelate	$C_{17}H_{24}O_3$	Used in the treatment of various blood vessel diseases	Phenanthrene	C14H10	Synthesis of drugs. Biochemical research			
Pyrethrin I	$C_{21}H_{28}O_3$	Botanical insecticides	Tetradecanoic acid	$C_{14}H_{28}O_2$	The antitumor activity			
Oleic acid	$C_{18}H_{34}O_2$	Fungicides-Acaricides. Herbicides. Insecticides. Plant growth regulators	Pentadecanoic acid	$C_{15}H_{30}O_2$	Agricultural chemicals (non-pesticidal) All other basic organic chemical anufacturing Food, beverage, and tobacco product manufacturing Paper manufacturing Plastics product manufacturing			
			Hexadecenoic acid, 2,3-Dihydroxypropyl Ester	$C_{19}H_{38}O_4$	Antiviral activity			
			Usnic acid	$C_{18}H_{16}O_7$	Antifungal agents. Anti-Infective agents. Anti-inflammatory activity			
			Isochiapin B	$C_{19}H_{22}O_6$	antimicrobial and antioxidant agents			
			Ethonafide	$C_{22}H_{22}N_2O_3$	Antibacterial – Antineoplastic			
			Metyrosine	$C_{10}H_{13}NO_3$	Human Drugs			
			Pyrethrin I	$C_{21}H_{28}O_3$	Botanical insecticides			
			Oleic acid	$C_{18}H_{34}O_2$	Fungicides-Acaricides. Herbicides. Insecticides, Plant growth regulators			
			Kinoprene	$C_{18}H_{28}O_2$	Insecticide			

Diversity in Egyptian soil's types were ideal for research since each type preserved a distinguished distribution of *Streptomycetes*. Fields cultivated with *Triticum aestivum*, *Vicia faba*, and *Citrus aurantifolia*, differed from those cultivated with *Beta vulgaris*, which exhibited greater colony-forming units per gram (CFUs/g) of S*treptomyces* population.

Previous studies shed the light about producing antimicrobial compounds in solid-culture medium is robustly efficient, compared to submerged-medium; where antimicrobial activities were significantly decrease or even cease, completely. For instance, Sapkota *et al*, 2020 demonstrated that nineteen, out of forty-one, isolates demonstrated antimicrobial properties in response to pathogens' treatments which they have used during preliminary assessment. The effect of antimicrobial compounds was also detected in gram-positive, as well as gram-negative bacteria, and the antimicrobial properties were determined to be 12 % of the total number of isolates. In secondary screening, thirteen out of nineteen active isolates showed an inhibition zone, in response to test organisms' treatment. Njoroge *et al*, 2018, pointed out that eight, out of the thirty-nine isolates in the culture filtrate that the authors have investigated, preserved a strong inhibition effect on pathogens such as fungi and bacteria. Our results go in line with previously published work since *Streptomyces*, isolated from Egyptian soils, grown in liquid medium have produced metabolites, which resulted in secretions that preserve effective antifungal properties. In contrast, Thakur *et al*, 2007, fifteen, among sixty-five isolates which have shown antimicrobial properties in solid medium, have not demonstrate such antibacterial properties in different medium, such as liquid medium. Although numerous researchers have claimed similar results, such as Salamoni *et al*, 2010 and Anibou *et al*, 2008, other researchers, such as Oliveira *et al*, 2010, accounted the antimicrobial properties in liquid medium due to the constrained synthesis of antibiotic compounds, however, antimicrobial compounds observation in liquid medium requires excessive amounts of such antimicrobial compounds. Numerous researchers and scientists have reported antifungal properties of *Streptomyces*. For example, Hong-Thao *et al*, 2016, were able to report *Streptomyces* isolate which preserved antimicrobial properties against *Fusarium oxysporum*. Another case reported by Kunova *et al*, 2016, where they reported *Streptomyces* isolate that showed antimicrobial properties in response to *Rhizoctonia solani* and *Fusarium oxysporum* f.sp. lactucae treatment. However, this study reveals that *Streptomyces*, isolated from Egyptian soils, preserved antimicrobial properties in response to *Fusarium oxysporum*, *Alternaria sesame* and *Rhizoctonia solani* treatment.

CONCLUSION

Streptomyces strains conserving antimicrobial properties in this manuscript have been collected and isolated from Egyptian agricultural soils. *Streptomyces* producing the highest CFUs/g were isolated from soil cultivated with *Beta vulgaris* plants. *Streptomyces vietnamensis*, *Streptomyces antibioticus* and *Streptomyces mediolani* have produced metabolites that prevented development and reproduction of phytopathogenic fungi; zones of inhibition were assessed to be larger than 10 mm in diameter (up to 32 mm). This manuscript demonstrates the collection, isolation molecular characterization of unique *Streptomyces* isolates, from Egyptian agricultural soils, in preventing phytopathogenic fungi development and reducing infection rates could be utilized in the future as a potential renewable source of antimicrobial substances. Precise identification of the active substances of microbial extracts in solid medium is our main interest in future research approaches.

RECOMMENDATIONS

This manuscript shed the light on the antimicrobial properties of *Streptomyces vietnamensis, Streptomyces antibioticus* and *Streptomyces mediolani* isolates from Egyptian agricultural soils, in response to phytopathogenic fungi treatment. We advise the spread and utilization of our isolates in controlled applications, such as *in vivo* or in greenhouse settings, as environment-friendly organisms against phytopathogenic fungi to confer protection to plants from economic pathogens.

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استخدام النواتج الايضية من الاستربتوميسس في مكافحة الفطريات المسببة لأمراض النبات

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الملخص

معظم أنواع الاستربتوميسس كائنات دقيقة فعالة فى المكافحة البيولوجية ضد العديد من مسببات الأمراض وبالتالي فإن جنس الاستربتوميسس يمكن وصفه بأنه أساس جميع المضادات الحيوية المستخدمة على الأرض. تستخدم المضادات الحيوية في من المجالات بما في ذلك الزراعة والطب قام مؤلفوا هذا العمل بعزل أنواع من الاستربتوميسس من عينات مختلفة من التربة والتي تم جمعها من عدة محافظات مصرية و تم تقييم النشاط التضادى لهذه العزلات ضد العديد من الفطريات المسببة للأمراض النباتية، مثل *Alternaria sesame* و *Fusarium oxysporum* و *Rhizoctonia solani*. أظهرت النتائج أن العزلات BF2 و BF16 و GH11 كانت العزلات الأكثر فعالية ضد الفطريات الممرضة للنبات. كما تم استخدم الإلكتروني والطرق الجزيئية ودراسة الصفات المورفولوجية التقليدية فى تعريف هذه العزلات. وأوضحت النتائج أن العزلات BF2 وBF16 و GH11 تنتمي إلى جنس Streptomyces. وتم تسجيلها فى (NCBI). وهى *Streptomyces vietnamensis* و*S. antibioticus* و*S.* mediolani على التوالي.

الكلمات الداله: المكافحة البيولوجية، الاستربتوميسس ، مسببات الأمراض النباتية ، NCBI