Unveiling the Antibacterial Properties of Plant Extracts: Insights and Innovations for Future Therapies

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ABSTRACT
In this comprehensive review, diverse studies on plant extracts and their antibacterial properties are synthesized. The investigations encompass various plant species, shedding light on their efficacy against different bacterial strains and presenting potential therapeutic applications. For instance, Anoectochilus formosanus extracts demonstrate antibacterial activity against Staphylococcus aureus, Bacillus cereus, Escherichia coli, and Pseudomonas aeruginosa. Zygophyllum simplex, particularly its dichloromethane extract, exhibits significant antibacterial activity against foodborne bacteria. Verbascum thapsus L. displays varying antibacterial efficacy between leaf and flower methanol extracts. Rheum khorasanicum root extract shows antibacterial activity, with the April sample exhibiting the highest overall efficacy. Green tea extracts, Nauclea species, Citrus essential oils, Cannabis sativa L., and Morinda coreia also demonstrate antibacterial potential against various strains. Cymodocea serrulata, Aloe vera/Morinda citrifolia extracts, and Salvadora Persica (Miswak) extract exhibit antibacterial and antibiofilm activities. Plocamium rigidum and Beilschmiedia genus show promise against Escherichia coli and multidrug-resistant bacteria. Allanblackia species, Harungana madagascariensis, Minthostachys verticillata essential oils, clove essential oil, and Garcinia species present antibacterial efficacy. Additionally, Primula plants in the Western Himalaya, Bridelia ferruginea leaf extracts, and traditional use in Africa for wound healing are explored. These studies collectively emphasize the potential of plant extracts as sources for novel antibacterial agents, urging further research and development in this area.

Keywords: Natural antibiotics, Anoectochilus formosanus, Zygophyllum simplex, Staphylococcus aureus, Natural antimicrobial agents, Multidrug-resistant bacteria.

1. INTRODUCTION

The alarming rise of antibiotic resistance poses a significant threat to global public health, rendering many conventional treatments ineffective and leading to an increase in persistent infections and mortality rates. The overuse and misuse of antibiotics have accelerated the emergence of resistant strains, challenging healthcare systems worldwide. As a result, there is a growing urgency to discover and develop novel antimicrobial agents that can effectively combat these resistant pathogens. In this context, the exploration of natural products, particularly plant extracts, has garnered considerable interest. Plants have long been a cornerstone of traditional medicine, offering a vast reservoir of bioactive compounds with diverse pharmacological properties, including antibacterial activity.

Plants produce a wide array of secondary metabolites, such as alkaloids, flavonoids, terpenoids, tannins, and essential oils, many of which have demonstrated potent antimicrobial effects. These compounds are part of the plants' natural defense mechanisms against pathogens, making them valuable candidates for developing new therapeutic agents. Unlike synthetic antibiotics, which typically target specific bacterial processes, plant-derived compounds often exhibit multiple modes of action, reducing the likelihood of bacteria developing resistance. Additionally, the structural diversity of these natural compounds offers a broad spectrum of activities against various bacterial strains, including those that are multidrug-resistant.
The resurgence of interest in phytotherapy is not just a response to antibiotic resistance but also reflects a growing recognition of the potential of natural products in modern medicine. Historically, plants have been used in different cultures to treat infectious diseases, with many traditional remedies being validated by contemporary scientific research. For instance, *Anoectochilus formosanus*, a plant traditionally used in East Asian medicine, has shown antibacterial activity against common pathogens such as *Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli*, and *Pseudomonas aeruginosa*. Similarly, *Zygophyllum simplex*, used in traditional medicine in arid regions, has been found to possess significant antibacterial properties, particularly in its dichloromethane extract, which is effective against foodborne bacteria.
The therapeutic potential of plant extracts is further underscored by studies on widely consumed plants such as green tea, which has been recognized for its broad-spectrum antibacterial activity, and *Cymodocea serrulata*, a seagrass known for its bioactive compounds with antibiofilm capabilities. Additionally, extracts from *Aloe vera* combined with *Morinda citrifolia*, and *Salvadora persica* (commonly known as Miswak), have shown promise not only in antibacterial applications but also in inhibiting biofilm formation, suggesting their potential use in both therapeutic and preventive healthcare.
This review aims to synthesize findings from diverse studies on the antibacterial properties of plant extracts, highlighting the efficacy of different plant species against various bacterial strains and exploring their potential applications in modern medicine. By providing a comprehensive overview of the antibacterial potential of plants such as *Cannabis sativa L.*, *Morinda coreia*, *Plocamium rigidum*, and others, this review seeks to underscore the importance of further research and development in this area. The goal is to inspire continued exploration into plant-based antibacterials, which could lead to the discovery of novel agents capable of addressing the escalating challenge of antibiotic resistance. As the pharmaceutical industry continues to seek new solutions to combat infectious diseases, the rich biodiversity of plant life offers a promising avenue for the development of innovative and effective antibacterial therapies.

2. Table 1. Antimicrobial Efficacy of Phytochemicals from Various Plant Extracts

S. No.	Plants Name	Extracts	Active Constituents	Microorganisms	Year	Reference
1	***Anoectochilus Formosanus Plant***	ethanol	*LDH, GOT, and GPT*	Staphylococcus aureus (MIC = 2500 µg/ml), Bacillus cereus (MIC = 2500 µg/ml), Escherichia coli (MIC = 2500 µg/	2023	[1]

				ml), and Pseudomonas aeruginosa (MIC = 1250 µg/ml).		
2	***Zygophyllum Simplex (Z. Simplex) I***	Ethylacetate, water order of DCM > butanol > water > methanol > hexane extracts preceded	flavonoids, mono- and diglycoside of three flavonols: kaempférol, quercetine, isorhamnetine, and saponoside	Two Gram-negative: Escherichia coli (E. coli, Code No. 683) and Klebsiella Pneumonia (K. pneumonia, Code No. 684), and three Gram-positive bacteria: Staphylococcus aureus (S. aureus, Code No. 659), Streptococcus pseudopneumonia (S. pseudopneumonia, Code No. 685), Bacillus pumilus (B. pumilus, Code No. 690	2023	2
3	***Eulaliopsis Binata***	(methanol, ethyl acetate, and hexane)	Lignin and cellulose fibre	Verbascum thapsus L., or Great Mullein, methanol leaf extract showed stronger antibacterial activity (50–62%) than flowers (42–54%) against respiratory pathogens, indicating effectiveness	2023	3
4	***Plectrunthus Amboinicus (Family Lamiacease) Fresh Leaf***	ethanolic	monoterepenoids, diteroenoids, triterpenoids, sesquiterpenoids, phenolics, flavonoids and esters	against Gram-positive bacteria. Bacillus subtilis and Staphylococcus aureus.	2023	4

	Cultivated In Sudan					
5	***Green Tea Leaves***	aqueous, ethanol, and methanol extracts	phenols, alkaloids, Flavoniods, tannins and steroids	specified Gram-positive and Gram-negative bacterial strains by a specific method	2023	5
6	***Nauclea* Species (Rubiaceae) Including Fruits, Roots, Bark, And Leaves Are Used**	Leaf ethanolic extracts	indoloquinolizidines alkaloids glycoalkaloids, indole-quinolizidine alkaloids, and saponins	against drug-sensitive and multi-drug resistant (MDR) bacterial strains. The antibiotic-resistance reversal potential has been also ascribed to the two species against MDR bacteria overexpressing efflux p	2023	6
7	***Moroccan Citrus Peel***	Essential oils	Flavonoids and phenolic acids	Essential oils, led by D-Limonene, showed potent antibacterial effects with MICs: 110-140 µg/mL for most strains, 200-220 µg/mL for MRSA	2023	7
8	***Cannabis***	extracts by the content of polyphenols, flavonoids, saponins, and volatile compounds,	*delta-9-tetrahydrocannabinol and cannabidiol*	Paenibacillus larvae is a gram-positive bacterium, Escherichia coli, and Staphylococcus aureus	2023	8
9	***Morinda Coreia (Mc)***	Methanoli c extract	presence of phenolics, flavonoids, alkaloids, glycosides, amino acids, proteins, saponins, and tannins	against *Pseudomonas aeruginosa* (19 ± 0.85 mm), Proteus sp. (20 ± 0.97 mm), Streptococcus sp.	25february 2023	9

				(21 ± 1.29 mm), and Enterobacter sp. (17 ± 0.2 mm)		
10	***Cymodocea Serrulata***	ethyl acetate extract of C. serrulate	against *S. aureus* (20 mm) followed by *P. aeruginosa* (18.11 mm), *E. coli* (17.20 mm), *B. subtilis* (17.11 mm), *C. diphtheriae* (17.10 mm) and *C. pneumoniae* (17.0 mm) at the concentration of 75 mg ml^{-1}	against Staphylococcus aureus, followed by Pseudomonas aeruginosa, Escherichia coli, Bacillus subtilis, Corynebacterium diphtheriae, and Chlamydia pneumoniae.	2023	10
11	***Extraction Of* Aloe Vera *And* Morinda Citrifolia**	Methanol	Pseudomonas aeruginosa	total phenolic and flavonoid contents in *A. vera* and *M. citrifolia* crude extracts and compare the two, chemical structure of *A. vera* consists of 2″-O-Feruloylaloesin, Kaempferol-3-O-rutinoside,	Volume 72, Part 6, 2023, Pages 2796-2802	11
12	***Salvadora Persica***	extracted with petroleum ether	Streptococcus species, Streptococcus oralis.	benzyl isothiocyanate (36.21%) and n-hexadecanoic acid (27.62%	8/ 2023	12
13	***Plocamium Rigidum***	methanol and dichloromethane extracts	E. coli and Pseudomonas aeruginosa and Natsudaidain. At the same time, the chemical structure of *M. citrifolia* consists of 7-Hydroxy-Methoxycoumarin and Cirsiumaldehyde.	against Escherichia coli, employing acute toxicity evaluation and therapeutic testing on 24 Balb/c mice.	Volume 19, March 2023, e01458	13
14	***Genus Beilschmiedia***	crude extract	MDR bacteria	endiandric acid derivatives are major constituents of this genus.	Volume 107, 2023,	14

	(Lauraceae)				Pages 37-65	
15	***Genus Allanblackia (Clusiaceae)***	Aqueous seed extracts	stearic acid (56.8%) and oleic acid (39.4%), followed by minor amounts of palmitic acid (3.2%), linoleic acid (0.4%), and eicosanoic acid (0.2%)	most active of them include 1,3,6,7-tetrahydroxy-2-(3-methylbut-2-enyl) xanthone (**1**), allanxanthone A (**2**), allanxanthone D (**3**), morelloflavone (**4**), and kaempferol (**5**). Finally, this chapter shows that within the genus *Allanblackia*, *A. gabonensis* and *A. floribunda* are the most investigated	Volume 107, 2023, Pages 1-3	15
16	***Harungana Madagascariensis***	Leaf extracts	MDR bacteria, including *Bacillus subtilis, Staphylococcus aureus, Escherichia coli, Salmonella typhi, Klebsiella pneumoniae, Acinetobacter* sp., and *Pseudomonas aeruginosa*.	*H. madagascariensis* include anthranoids, namely ferruginin A, euxanthone, harunmadagascarin D, kenganthranol C, and astilbin. Conclusively, *H. madagascariensis*	Volume 107, 2023, Pages 177-191	16
17	***Genus Fagara (Rutaceae)***	Leaves methanol extracts	MDR bacteria	canthine-6-one (**5**), 8-acetonyldihydrochelerythrine (**10**), 8-oxochelerythrine (**11**), and 10-methoxycanthin-6-one (**12**) isolated from *F. paracanthum,* benzo phenanthridines alkaloids, buesgenine (**1**) isolated in *F. tessmannii* and avicine (**8**), and chelerythrine (**9**)	2023, Pages 67-104	17

				isolated in *F. rhoifolium* as potential antibacterial agents.		
18	***Minthostachys Verticillata Essential Oils,***	Essential oils	pulegone (63.4%), menthone (15.9%), and limonene (2.1%)	Staphylococcus aureus, against S. aureus.	2023	18
19	***Clove Essential Oil***	Essential oils	Eugenol (4-allyl-2-methoxyphenol)	Staphylococcus aureus (S. aureus) 0.52 mg/ml than against Escherichia coli (E. coli) 0.64 mg/ml	2023	19
20	***Garcinia Brevipedicellata And G. Epunctata***	Methanol extract	hydroxycitric acid, garcinol, and cambogin	multidrug-resistant (MDR) strains	2023	20
21	***Avocado Kernels And Mango Kernels .***	mixture of equal proportions of petroleum ether extract from avocado kernels and methanolic extract from mango kernels	staphylococcus aureus and P. aeruginosa	efficacy against Staphylococcus aureus. Minimal inhibitory concentrations (MIC) on Staphylococcus aureus were lower for the blend (0.019mg/mL)	2022	21
22	***Leaves Of Blumea Balsamifera Lin. (Dc)***	extracted hexane, ethyl acetate, and 50% aqueous methanol	*Escherichia coli* O157: H7, Pseudomonas aeruginosa, and Bacillus cereus.	Cytotoxicity assays revealed strong cytotoxicity of HES against HeLa cells (IC50 24 µg/mL) and moderate activity against MCF-7 (156 µg/mL).	2022	22

23	***Both Thyme And Garlic As Herbal Antibacterial Extract***	chitosan solution containing herbal extract was uniformly coated on the membrane surface.	Gram-positive and Gram-negative bacteria (El-Azzouny et al., 2018). *Zataria multiflora* Boiss (*Z. multiflora* Boiss- Shirazi thyme)	garlic extracts into chitosan-based membranes, enhancing antibacterial efficacy, water flux, and antifouling properties, suggesting versatile applications	2022	23
24	***Peptide Fractions Euphorbia Hirta And Nauclea Diderichii***	The peptide fraction and crude extracts were screened for their antimicrobial activities using the broth microdilution	The peptide fraction and crude extracts were screened for their antimicrobial activities using the broth mi	against gram-positive and gram-negative bacteria and fungi (MIC = 7.8, 15.63-62.5, and 7.8 µg/mL, respectively).	2022	24
25	***Calotropis Procera (Family Apocynaceae)***	Ground twigs, leaves and flowers of the plant were extracted in *n*-hexane, dichloromethane and methanol by successive cold maceration method.	*Bacillus* sp., *Staphylococcus* spp. *Klebsiella pneumoniae* and *Proteus vulgaris*. The MIC and MBC values of the MeOH extracts were in the range of 5–40 mg/mL against *B. cereus, Staphylococcus* spp., *K. pneumoniae* and *P. vulgaris*.	presence of flavonoids, terpenoids, steroids, phenolics, carbohydrates and resins in the crude extracts.	2022	25
26	***Lemongrass, Sage, And Guava Leaf***	Ethanol (96%) and dimethyl sulfoxide (	(Streptococcus mutans, Staphylococcus aureus, and Enterococcus faecalis).	highest content of antioxidants, phenols, and flavonoid compounds.	2022	26

		DMSO) were purchased from Fisher Scientific.				
27	***Primula*, Commonly Known As Primroses, Belongs To The Family Primulaceae**	Leaves	two Gram-positive bacteria (*Staphylococcus aureus*, *Bacillus cereus*) and three Gram-negative bacteria (*Achromobacter xyloxidans*, *Escherichia coli*, *Pseudomonas aeruginosa*).	antibacterial activity against both gram-positive and gram-negative bacteria.	2022	[27]
28	***Prunella Vulgaris***	methanol and petroleum ether extracts	P. vulgaris extract against gram positive (Streptococcus pneumo-nia, Enterococcus faecalis and Staphylococcus aureus) and gram negative (Escherichia coli and Klebsiella pneumonia) bacterial strains.	the isolated compound was identified as [(2-(E)-3-(3-4-dihydroxyphenyl) acryloyloxy)-3-(3, dihydroxyphenyl) propanoic acid (Rosmarinic acid)] from the active fraction of P. vulgaris flower extract. In conclusion P. vulgaris	2022	[28]
29	***Haplophyllum Tuberculatum (H. Tuberculatum)***	extracted with methanol	H. tuberculatum species	antimicrobial activities with 2,2-diphenyl-1-picrylhydrazyl (DPPH	2022	[29]
30	***Embelia Ruminata***	Methanolic Seed extract	*Gram +,- bacteria Chromobacterium subtsuagae , Chromobacterium violaceum*	Embelia ruminata extracts containing embelin exhibited antibacterial and anti-quorum sensing activities, suggesting potential therapeutic applications	2022	[30]

31	***Alfalfa ,Fabaceae Family***	extracted chlorophyll from alfalfa	Listeria < Staphylococcus < *Salmonella* < Escherichia < Pseudomonas and *Listeria*<(*Staphylococcus = Escherichia = Salmonella*)<*Pseudomon*	tocopherols, flavonoids, chlorophylls, and pigments of plant	2022	31
32	***Aspidosperma Quebracho-Blanct, Sarcomphalus Mistol, Geoffroea Decorticans, Prosopis Chilensis, Larrea Divaricata* And *Larrea Cuneifolia*) From Catamarca**	Leaves extracts	S. aureus and E. faecalis strains	f Larrea and S. mistol species,	2022	32
33	***Centaurothamnus Maximus***	Ethanol extracts	***guaianolide sesquiterpenes lactones, spiro[azuleno[4,5-b]furan-6(2H),2'-oxirane***]	gainst *B. subtilis* ATCC 6633, *S. aureus* ATCC 25923 and *S. pyogenes* ATCC 27736,	2022	33
34	***Polylysine Plant Extracts Of Thymus Vulgaris, Zataria Multiflora***	herbal extracts	L-lysine or D-lysine	bacterium Pseudomonas aeruginosa and Pectobacterium carotovorum.	2022	34

	, And Salvia Verticillata					
35	***Thamnolia Vermicularis (Tv) And Thamnolia Subuliformis (Ts)***	crude extracts	β-Sitosterol and vermicularin	against gram-positive bacteria in vitro.	2022	35
36	***Olea Europaea***	cold methanolic extract	unique bioactive compounds, including 9,12-octadecadienoic acid (Z,Z)-, n-hexadecanoic acid, 9-octadecenamide, (Z)-, hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester, squalene, 2-(2-Hydroxy-2-phenylethyl)-3,5,6-trimethylpyrazine, Benzoic acid, 4-formyl-, methyl ester, 2-Methoxy-4-vinylphenol, Vitamin E etc.	broader spectrum of antibacterial activity.	2022	36
37	***Rosemary Essential Oil (Reo)***	Crude	1,8-cineole (43.77%), camphor (12.53%), and α-pinene (11.51%)	Salmonella enterica serovar Typhimurium infection,*Salmonella* spp. is one of the most common Gram-negative foodborne pathogens	2022	37
38	***Adventitious Root (Ar) Cultures Of***	70% ethanol	quassinoids, alkaloids, and terpenoids	Staphylococcus aureus	2022	38

	Eurycoma Longifoli					
39	***Aconitum Heterophylum***	Successive soxhlet extraction of seed and root	*Escherichia coli, Bacillus subtilis* and *Staphylococcus aureus* and it was observed that all extracts	Linoleic acid is a dominant unsaturated fatty acid	21	[39]
40	***Rosa Chinensis***	three extracts, PE, 95 % ethanol, and 65 % ethanol extract	*S. aureus*. Compounds **6** and **13** also exhibited moderate inhibitory effects against *Klebsiella pneumoniae, Escherichia coli* ATCC25922, *Pseudomonas aeruginosa* PA01, *Klebsiella peneumoniae* ATCC13883, and *Staphylococcus aureus* ATCC292	chemical constituents of the flower by 1,1-diphenyl-2-picrylhydrazyl (DPPH	2021	[40]
41	***Neem Leaf***	Water	for staphylococcus aureus, salmonella typhi bacteria	including 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging, elastase inhibition, anti-tyrosinase, and antibacterial assays. Results indicated that both 95% and 65% ethanol extracts from neem leaves exhibited significant antioxidant, elastase inhibition, and anti-tyrosinase activities	Volume 44, Part 1, 2021, Pages 523-526	[41]
42	***Aerva Lanata***	Methanol extract of A. lanata	pathogens Staphylococcus aureus (3–20 mm), *Pseudomonas aeruginosa* (9–25 mm), *Salmonella* species	phytochemicals (tannins, flavonoids, steroid, phenolics, quinones, and cumarin)	2021	[42]

			(10–23 mm), *Streptococcus pneumoniae* (3–16 mm), and *Escherichia coli* (10–24 mm			
43	***Feijoa Leaf Extracts***	PLE extract (80 °C/ethanol–water/dynamic) provided the highest yield, total phenolic content,	ffectiveness against *S. aureus*, *E. coli,* and *S. typhimurium*, with minimum inhibitory concentration values	catechin and isoquercetin were the major phenolics identified by liquid chromatograph	2021	43
44	***Curcuma Amada, Commonly Known As Mango Ginger***	methods, such as hydrodistillation, steam distillation, microwave-assisted extraction, and ultrasound-assisted extraction, result in the variation of volatile organic compounds in essential oil	larvicidal activity against Aedes, Culex, and Armigeres species	g α-pinene, β-myrcene, p-cymene, (Z)-β-ocimene, Camphor, linalyl acetate, safrole, ar-curcumene, and β-curcumene in the differen	2021	44
45	***Musa Paradisiaca, Musa Acuminata And Musa Sapientum***	80% ethanolic leaf extracts	*M. paradisiaca* and *M. acuminata* at the concentration of 2.86 g/mL and 3.33 g/mL respectively, exhibited similar inhibitory effect ($p \leq 0.05$) against the tested bacteria when compared with the	presence of phytochemicals such as alkaloids and tannins that inhibited the bacterial growth	2021	45

			positive control, clindamycin.			
46	***Leaves Of Mentha Piperita***	70% ethanol	antibateria	major compounds from peppermint, like rosmarinic acid		46
47	***Piper Nigrum***	methanol extract	activity against methicillin-resistant Staphylococcus aureus (MRSA) was found to be more prominent compared to ESbL producing Klebsiella pneumoniae isolates. The MIC values were found to be lower against MRSA than K. pneumoniae	a more prominent antibacterial impact on MRSA, with lower Minimum Inhibitory Concentration (MIC) values against MRSA than Klebsiella pneumoniae. This suggests the extract's heightened potency against MRSA, emphasizing its potential as a natural antimicrobial agent	2021	47
48	***Aerva Lanata Flower Extract.***	methanol extract	bacterial pathogens Staphylococcus aureus (3–20 mm), *Pseudomonas aeruginosa* (9–25 mm), *Salmonella* species (10–23 mm), *Streptococcus pneumoniae* (3–16 mm), and *Escherichia coli* (10–24 mm)	xtract contains more number of phytochemicals (tannins, flavonoid, steroid, phenolics, quainones, and cumarin)	2021	48
49	***Rosmarinus Officinalis L.***	ethanol extract	against Bacillus subtilis	Staphylococcus aureus, Enterococcus faecalis, Streptococcus mutans	2021	49
50	***Bark Of Ochna Kirkii***	methanolic extract	Gram-positive bacterium Bacillus subtilis with MIC	Isolation of biflavonoids and related secondary metabolites	2021	50
51	***Stems And Leaves Of***	Ethanolic	pathogenic bacteria, *Bacillus cereus*, *Bacillus*	aryl alkanone, piwalkanone (**1**) and a dioxoaporphine	2021	51

	Piper Wallichii		*subtilis* and *Staphylococcus aureus.*	alkaloid, piwallidione (**2**), together with nine known compounds, a dioxoaporphine alkaloid, cepharadione A (**3**); two aristolactams, piperolactam A (**4**) and stigmalactam (**5**); a piperidine, piperine (**6**); four isobutylamides, piperlonguminine (**7**), pellitorine (**8**), *N*-isobutyl-*2E,4E*-octadecadienamide (**9**), and guineensine (**10**); and a tyramine, *N-trans*-feruloyltyramine (		
52	***Xylopia* St audtii *Is A Medicinal Plant Which Fruits Are Traditionally Used In Western Cameroon As A Spice***	Crude extract	pathogens, including Shigella spp, which are responsible of the deathly dysenteric diarrhoea	antibacterial effects against Shigella and bacteriostatic activity against Escherichia coli	2021	[52]
53	***Citrus Hystrix***	Ethanol	Salmonella typhimurium.	antibacterial activity against S. typhimurium,	2021	[53]
54	***Ethiopian Kale Leaves***	solvents like acetone, chloroform, ethyl	gainst Staphylococcus spp. (15 mm) and followed by E.coli (12 mm), against Listeria	hytoconstituents namely alkaloids, flavonoids, glycosides, steroids, and carbohy-	2021	[54,55]

		acetate, petroleum ether, ethanol, and distilled water for 24 h at 30 °C under shaking conditions	spp,psudemonas,,streptococus,Neisseria,	drates		
55	***Guava Leaf Extract***	Chloroform extraction	both Gram-positive bacteria (GP-B) and Gram-negative bacteria (GN-B) have been documente	L-β-(3,4 dihydroxilphenyl) alanine (L-DOPA), 1,1,3,3-tetramethoxypropane copper (II) sulfate, tetramethylmurexide (TMM), potassium carbonate, thiobarbituric acid trichloroacetic acid (TCA)	2021	[56]
56	***Aronia Melanocarpa Anthocyanins***	e crude anthocyanin extract and then the extract was purified using NKA-9 macroporous resin	against Escherichia coli.	AMAs exhibited strong antibacterial activity, with a minimum inhibitory concentration (MIC) of 0.625 mg/mL and a minimum bactericidal concentration (MBC) of 1.25 mg/mL against E. coli	2021	[55]
57	***Tetraena***	ethyl acetate extract	against two gram-positive bacteria (*Streptococcus pneumoniae* and *Staphylococcus aureus*) and three gram-negative bacteria (*Escherichia coli*, *Klebsiella pneumoniae*, and Proteus bacilli)	including beta-carotene, lycopene, proanthocyanidins, and flavonoids,	2020	[57]

58	***Lepidium Sativum L. Seeds***	compositions of the petroleum ether	against two Gram negative (*Klebsiella pneumoniae* and *Escherichia coli*) and two Gram positive (*Staphylococcus aureus* and *Bacillus cereus*)	EO isolated by CTA. 1-Isocyano-2-methylbenzene (71.63 %) and benzaldehyde (11.21 %) were the most predominant components. About 98.53 % of the oil extracted by SDE exhibited a wide range of compounds with 1-isocyano-2-methylbenzene (36.18 %), benzyl isothiocyanate (8.71 %), and benzaldehyde (2.96 %) as the major constituent	2020	[58]
59	***Camellia Oleifera Shells,***	eluent ethanol concentration is 95 %, and the eluent pH is 9. Tea saponin	bacteriostatic effect on *Escherichia coli* and *Staphylococcus aureus* with its minimum inhibitory concentration of 1 and 0.5 mg/mL, respectively	tea polyphenol (Liau et al., 2017), tea saponin (Cai et al., 2016) and squalene	2020	[59]
60	***Lemna Minor Extracts***	extraction. Methanol, chloroform and hexane were used	against Pseudomonas fluorescens	antibacterial activity against Pseudomonas fluorescens	2020	[60]
61	***Flowers Of Poppy (*Papaver *Rhoeas L.) Plant Belonging To The Family Of* Papaveraceae,**	Two types of methanolic extraction methods (maceration, soxhlet)	against six types of bacterial species, half of which are *Gram*$^-$ (*Escherichia coli*, *Klebsiella pneumonia*, *Salmonella spp*) and the others are *Gram*$^+$ (*Staphylococcus aureus*, *Listeria*	The results revealed rich total phenolic concentrations in both extracts, with values of 95.4±2.42 and 165.4±3.84 mg GAE/g for maceration and soxhlet	2020	[61]

			monocytogenes, and *Enterobacter feacalis*).			
62	***Ginkgo Biloba Leaves***	A novel high energy ball milling extraction technology coupled with silver-thiolate material purification method was developed, with which a high purity of GBL polyprenol (GBP	against Staphylococcus aureus, *Escherichia coli*, Candida albicans and Streptococcus pneumoniae, a	against the tested bacteria and fungi	2020	62
63	***Cissus Incisa***	crude CHCl3/MeOH extract	against Pseudomonas aeruginosa resistant to carbapenems.,against Pseudomonas aeruginosa resistant to carbapenems.	five compounds: 2-(2′-hydroxydecanoyl amino)-1,3,4-hexadecanotriol-8-ene **(1)**, 2,3-dihydroxypropyl tetracosanoate **(2)**, *β*-sitosterol-D-glucopyranoside **(3)**, *α*-amyrin-3-*O*-*β*-D-glucopyranoside **(4)**, and a mixture of cerebrosides	2020	63
64	***Two Cardamom Extracts (Fruit And Seeds), Cardamom (Elettaria Cardamomum***	fruit and seeds extracts	Aggregatibacter actinomycetemcomitans, Fusobacterium nucleatum, Porphyromonas gingivalis, and Prevotella intermedia (minimum inhibitory concentrations: 0.5% [v/v], 0.25%, 0.062%, 0.125%, respectively	Microorganisms, including bacteria, viruses, fungi, and protozoa, are pervasive in nature and often invisible to the naked eye	2020	64

			and minimum bactericidal concentrations: 1%, 0.25%, 0.062%, 0.25%, respectively). The cell membrane of *P. gingivalis* was disrupted by a treatment with cardamom extracts suggesting the bactericidal mode of action			
65	***Lycoperdon Pyriforme, Agaricaceae Family***	hexane extract	s antibacterial activity of S. aureus	The most predominant compounds of *Lycoperdon pyriforme* was Ergosta-5, 7-dien-3-ol.	2020	65
66	***Leaves Of Mallotus Oppositifolius***	Ethanolic and aqueous leaf extracts	activity against the bacterial strains *E. coli, S. aureus, S. typhi,* P. aeruginosa with minimum inhibitory concentration	Mallotus oppositifolius leaves for antibacterial phloroglucinol derivatives, highlighting potential as natural sources for novel antibacterial agents	2020	66
67	***Ficus Auriculata***	extracted with 95% EtOH	Five pathogenic bacteria Pseudomonas aeruginosa (ATCC 9027), Bacillus cereus (ATCC 14579), Escherichia coli (ATCC 8379), Staphylococcus albus (ATCC 8032) and Staphylococcus epidermidis (ATCC 12,228) were used	Ficus auriculata extract, obtained using 95% ethanol, exhibited antibacterial activity against five pathogenic bacteria strains	2020	67
68	***The Stems And Roots Of* Thuja Sutchuenensis.**	Ethanolic extract	inhibitory effect against *Staphylococcus. aureus* (CMCC 26003), methicillin-resistant *Staphylococcus*	stems and roots displayed inhibitory effects against Staphylococcus aureus (CMCC	2020	68

			aureus (JCSC 4744), *Bacillus cereus* (ATCC 10876), and *Staphylococcus epidermidis* (ATCC 12228	26003), methicillin-resistant Staphylococcus aureus (JCSC 4744), Bacillus cereus (ATCC 10876), and Staphylococcus epidermidis (ATCC 12228)		
69	***Atractylodes Lancea (Thunb.)***	Ethanol,water	antibacterial activities against Gram-positive and Gram-negative bacteria	The antibacterial activity was assessed against various bacterial strains, including Staphylococcus aureus ATCC 25923, Bacillus cereus ATCC 14579, Bacillus subtilis ATCC 6633, Escherichia coli ATCC 25922, Proteus vulgaris ATCC 12453, and Pseudomonas aeruginosa	2020	[69]
70	***Leaves Of Mallotus Oppositifolius***	CH2Cl2/MeOH or with EtOH/H2O.	activity against the bacterial strains *E. coli, S. aureus, S. typhi,* P. aeruginosa with minimum inhibitory concentration (M	The study assessed the minimum inhibitory concentration (MIC) values of these derivatives against bacterial strains, including E. coli, S. aureus, S. typhi, and P. aeruginosa. The MIC values ranged from 3.125 to 50 µg/ml	2020	[70]
71	***Aerial Parts Of Siegesbeckia***	Methanol extracts	antibacterial activity against two Gram-positive bacteria	Antibacterial activity against two Gram-positive bacterial strains	2020	[71]

	Glabrescens					
72	***Triphala (Terminalia Bellirica, Terminalia Chebula And Emblica Officinalis***	extracted using solvents of varying polarity (methanol, water, ethyl acetate) and the antibacterial activity of the aqueous resuspensions	against S. aureus	Antibacterial activity against S. aureus	2020	72
73	***Trollius Altaicus***	the water, ethanol, and n-butanol extracts	Streptococcus mutans	Activity against Streptococcus mutans	2020	73
74	***Nelumbo Nucifera.***	70% ethanol	Aspergillus cejpii, *Escherichia coli*, *Klebsiella pneumonia, Haemophilus* sp., vancomycin-resistnat *Enterococcus* (VRE), Methicillin-resistant *Staphylococcus aureus* (MRSA), as well as opportunistic pathogens	Antifungal activity	2020	74
75	***Brazilian Peppertree***	Leaves and fruits	antibacteria	Microbes	2020	75
76	***Alchornea Laxiflora***	Many solvent polarities including: hexane (Hex), chloroform ($CHCl_3$), ethyl	Gram positive bacteria viz.; *Bacillus cereus* (ATCC 11778), *Enterococcus faecalis* (ATCC 29212), *Staphylococcus aureus* (ATCC 25923) and *Staphylococcus saprophyticus* (ATCC	ellagic acid (**1**); 3-*O*-methyl-ellagic acid (**2**), 3-*O*-*β*-D-glucopyranosyl-*β*-sitosterol (**3**), 3-*O*-acetyl-oleanolic acid (**4**) and 3-*O*-acetyl-ursolic acid (**5**	May 2019	76

		acetate (EtOAc), ethanol (EtOH), methanol (MeOH) and water (H_2O).	15305)] and Gram-negative bacteria, i.e., *Escherichia coli* (ATCC 25922), *Klebsiella pneumoniae* (ATCC 13883), *Moraxella catarrhalis* (ATCC 23246)			
77	***Caesalpinia Sappan L. Heartwood,Family Of Leguminosae***	Ethanol extract and petroleum-ether extract	Staphylococcus aureus TISTR 1466, Staphylococcus epidermidis TISTR 518 and Propionibacterium acnes DMST 14961	Brazilinss	2019	[77]
78	***Hancornia Speciosa***	Extract purification with n-hexane led to higher phenolic and flavonoid concentration. Higher amount of phenolic compounds in the extract was obtained using ethanol/water as solvent. The separation of flavonoids was favored using ethyl	against nosocomial multidrug-resistant E. coli.	Hancornia speciosa leaf extract, obtained through pressurized liquid extraction, exhibited potent antibacterial activity against multidrug-resistant E. coli, highlighting therapeutic potential	2019	[78]

		acetate in the sequential extractions.				
79	***Tribulus Terrestris L. Leaves***	ethanol solution,	tandard strains Escherichia coli (ATCC 25922), Salmonella (ATCC 51812), Staphyloccocus aureus (ATCC 25923) and Streptococcus (ATC	Exhibited good antibacterial activity against all bacteria	2019	79
80	***Citrus Reticulate Blanco (Ponkan)***	Essential oils	antibacterial activity against Cutibacterium acnes (*C. acnes*, Formerly *P. acnes*) and common microorganisms such as *S. aureus*, *B. subtilis*, and *E. coli*. Even compared with the common antibiotics (such as erythromycin, clindamycin, and tetracycline) for acne therapy, its antibacterial activity against *C. acnes* i	Terpenes compounds accounted for 71.2%, especially d-limonene (major	2019	80
81	***Lepechinia Meyenii (Walp.) Epling (Lamiaceae***	Ethanolic extracts	pathogenic bacteria was used, especially methicillin-susceptible *Staphylococcus aureus* (MSSA) and methicillin-resistant *S. aureus* (MRSA).	Lepechinia meyenii extracts and compounds (carnosol, rosmanol, carnosic acid) showed potent antibacterial effects, especially against drug-resistant strains, suggesting therapeutic potential	2019	81
82	***Suaeda Maritima (S. Maritima)***	methanol extract	wo Gram-positive and two Gram-negative bacteria strains.	Suaeda maritima hexane extract exhibited potent antibacterial activity against Gram-	2019	82

	Subfamily Suaedoideae In The Family Chenopodiaceae..			positive and Gram-negative strains, suggesting medicinal potential for infectious diseases		
83	***Clitoria Ternatea***	solvents such as acetone, iso propyl alcohol and petroleum ether and the extract yield was higher in acetone than the other two solven	Proteus mirabilis	Clitoria ternatea extracts, particularly acetone extracts, demonstrated notable antibacterial efficacy against Proteus mirabilis, suggesting its potential as an antibacterial source	2019	[83]
84	***Alchornea Laxiflora***	Root methanol extract of Alchornea laxiflora, laxiflora extracts (EtOH, MeOH, EtOAc and CHCl3)	against HIV integrase and bacteria	Alchornea laxiflora extracts and compounds, including 3-O-β-d-glucopyranosyl-β-sitosterol, demonstrated potent anti-HIV and antibacterial activities, suggesting therapeutic applications	2019	[76]
85	***Azadirachta Indica (Neem)***	ethanolic extract of Neem	Streptococcus mutans	Oliveria decumbens derivatives demonstrated antibacterial, immunostimulatory, and antioxidant effects, enhancing Nile tilapia's defense against Streptococcus iniae for improved overall health	2019	[84]

86	***Oliveria Decumbens,***	hydroethanolic extract	against Streptococcus iniae	Oliveria decumbens derivatives demonstrated antibacterial, immunostimulatory, and antioxidant effects, enhancing Nile tilapia's defense against Streptococcus iniae for improved overall health	2019	85
87	***Bletilla Striata, Rchb.F. Belongs To The Family Of Orchidaceae***	Ethanolic	antibacterial activities against three gram-positive bacterial strains and one gram-negative bacterial strain.,against S. aureus ATCC	Bletilla striata tubers, exhibit potent antibacterial activities, particularly against Staphylococcus aureus, including Methicillin-resistant strains	2019	86
88	***Allium Saralicum R.M. Fritsch Leaves.***	Ethanolic extract	prevented the growth of all bacteria and fungi	Allium Saralicum leaf extract displays significant cell viability, antioxidant activity comparable to BHT, and superior antimicrobial effects, suggesting versatile bioactive potential	2019	87
89	***Crude Extract Of Olea Ferruginea Stem,***	crude	against *Leishmania tropica* KWH23 promastigotes at 100 µg/mL concentration,	Ferruginan from Olea ferruginea inhibits Leishmania tropica by 98% at 100µg/mL in 48 hours, showing potential as a therapeutic agent	2019	88

1. Nguyen et al. found that ethanol extracts of *Anoectochilus formosanus* exhibit antibacterial activity against *Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli*, and *Pseudomonas aeruginosa*, with MICs of 2500 µg/ml and 1250 µg/ml. The extracts may also promote wound healing, suggesting therapeutic potential.

2. Ahmed et al. found that *Zygophyllum simplex* extracts showed strong antibacterial activity, especially the dichloromethane (DCM) extract, which was most effective against *Escherichia coli*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Streptococcus pseudopneumoniae*, and *Bacillus pumilus*. The efficacy ranked as DCM > butanol > water > methanol > hexane.
3. *Verbascum thapsus* L., or Great Mullein, has been traditionally used for treating lung ailments and respiratory diseases. A study found that the methanol extract from its leaves exhibited slightly stronger antibacterial activity (50–62%) compared to the flowers (42–54%). This extract was effective against *Streptococcus pneumoniae*, *Pseudomonas aeruginosa*, and *Haemophilus influenzae*, demonstrating its potential as a natural remedy for respiratory infections.
4. In the study by Mehrabani et al., the antibacterial activity of *Rheum khorasanicum* root extract was evaluated against both Gram-positive and Gram-negative bacteria. The study found that the antibacterial efficacy varied with the time of sample collection. Among the samples collected in December, February, and April, the April sample demonstrated the highest antibacterial activity overall, suggesting that the timing of harvest may influence the extract's potency.
5. The study evaluated the antibacterial efficiency of green tea extracts (aqueous, ethanol, and methanol) against both Gram-positive and Gram-negative bacterial strains. Among the extracts, the ethanol extract showed the highest inhibition, particularly against *Bacillus subtilis*. Conventional antibiotics like gentamicin, neomycin, and ciprofloxacin were effective against the bacteria tested, while chloramphenicol, methicillin, and vancomycin faced resistance in Gram-negative bacteria. Additionally, colistin was resisted by Gram-positive bacteria, indicating selective antibiotic resistance.
6. Kuete et al. found that *Nauclea* species, traditionally used for various ailments, exhibit strong antibacterial effects against drug-sensitive and MDR bacterial strains. Notably, *Nauclea latifolia* and *N. pobeguinii* can reverse antibiotic resistance in MDR bacteria by targeting efflux pumps, highlighting their potential for developing new therapies.
7. Essential oils extracted from the peel by-products of *Citrus limonum* (Lemon), *Citrus reticulata* (Mandarin), and *Citrus paradisi* (Grapefruit) were tested for antibacterial activity against *Escherichia coli*, *Enterococcus faecalis*, *Staphylococcus aureus*, *Candida albicans*, and *Saccharomyces cerevisiae*. Minimum inhibitory concentrations (MICs) were assessed by a resazurin color change assay. The study highlights the antimicrobial potential of these citrus essential oils, demonstrating their efficacy against various microbial strains and suggesting promising applications for further research.
8. Giselle et al. investigated the antibacterial activity of *Cannabis sativa* L. female inflorescence and root extracts against *Paenibacillus larvae*, the cause of American foulbrood, as well as *Escherichia coli* and *Staphylococcus aureus*. The extracts were analyzed for polyphenols, flavonoids, saponins, and volatile compounds. The study aimed to assess the antibacterial effects of *Cannabis* extracts and explore the roles of these compounds in the observed activity against specific bacterial strains.
9. Devanesan et al. reported that *Morinda coreia* exhibits antibacterial activity against various bacteria, including *Pseudomonas aeruginosa*, *Proteus* sp., *Streptococcus* sp., and *Enterobacter* sp. The plant is rich in phytochemicals such as phenolics, flavonoids, alkaloids, glycosides, amino acids, proteins, saponins, and tannins. These constituents contribute to its therapeutic potential, making *Morinda coreia* a promising source of natural antibacterial agents and underscoring its value in traditional medicine and antimicrobial development.
10. In Narayanan et al.'s study, the ethyl acetate extract of *Cymodocea serrulata* showed significant antibacterial and antioxidant activity. It was particularly effective against *Staphylococcus aureus*,

followed by *Pseudomonas aeruginosa*, *Escherichia coli*, *Bacillus subtilis*, *Corynebacterium diphtheriae*, and *Chlamydia pneumoniae*. These results highlight the plant extract's potential in inhibiting various bacterial strains and its broader therapeutic applications, suggesting *Cymodocea serrulata* as a promising candidate for further pharmaceutical and medical research.

11. The study found that *Aloe vera* and *Morinda citrifolia* extracts had high MICs of 6144 µg/mL against *Pseudomonas aeruginosa*, compared to Enrofloxacin's 16 µg/mL. *M. citrifolia* had higher phenolic content, while *A. vera* showed antioxidant activity but limited antibacterial effects, suggesting a need for further research.
12. El-Sherbiny et al. found *Salvadora persica* (Miswak) extract effective in oral hygiene, with MICs of 6.25 to 12.5 mg/mL against β-lactam-resistant *Streptococcus* species. It suppressed *Streptococcus oralis* biofilm by 68.66% and showed antioxidant activity with IC50 values of 20 µg/mL (DPPH) and 35 µg/mL (ABTS).
13. The *Plocamium rigidum* extract showed moderate toxicity (LD50 of 355 mg/kg) in 24 Balb/c mice and demonstrated potential against *Escherichia coli*. While it suggests promise as a therapeutic agent, further research, including preclinical and clinical trials, is needed to confirm its safety and efficacy for broader use.
14. *Beilschmiedia* from the Lauraceae family shows potent antibacterial activity against multidrug-resistant bacteria, attributed to endiandric acid derivatives. This highlights its potential as a source of natural antibiotics. Further research is needed to understand its mechanisms and develop pharmaceutical applications to address antibiotic-resistant pathogens effectively.
15. Fankam et al. explored the antibacterial potential of *Allanblackia* species from the Clusiaceae family against both drug-sensitive and drug-resistant bacteria. Phytochemical analyses of *Allanblackia gabonensis* and *Allanblackia floribunda* identified various compounds. The genus showed variable antibacterial activity, suggesting its potential as a source for new antibacterial agents. Further research is needed to develop phytomedicines targeting drug-resistant infections.
16. Kuete et al. found that *Harungana madagascariensis* has antibacterial activity against drug-sensitive and multidrug-resistant bacteria, including *Bacillus subtilis* and *Pseudomonas aeruginosa*. The plant's major antibacterial compounds include anthranoids like ferruginin A and euxanthone. This suggests its potential for developing treatments for bacterial infections, including resistant strains.
17. Kuete et al. investigated the antibacterial potential of the *Fagara* genus from the Rutaceae family, traditionally used for bacterial diseases. The study found that *Fagara* species are effective against both drug-sensitive and drug-resistant bacteria, with alkaloids identified as major constituents. This suggests *Fagara* could be a valuable source for developing new treatments, particularly for resistant infections, and underscores the need for further research.
18. Moliva et al. assessed essential oils (EO1 and EO2) from *Minthostachys verticillata* against *Staphylococcus aureus* strains causing mastitis. The oils inhibited bacterial growth and reduced biofilm by 36.4% to 96.06%. EO1 was more effective and, when used in an emulsion, reduced bacterial load in cows, suggesting its potential for infection management.
19. Bai et al. investigated clove essential oil (CEO) and its predominant compound, eugenol, against foodborne pathogens. Eugenol effectively inhibited the growth of *Staphylococcus aureus* and *Escherichia coli*, disrupting biofilm and cell structure. It activated oxidative stress-mediated apoptosis in *S. aureus*, inhibited biofilm formation, and caused leakage of intracellular macromolecules, affecting cell walls and membranes.

20. Akongy et al. found that methanol extracts from *Garcinia brevipedicellata* and *Garcinia epunctata* effectively inhibited multidrug-resistant Salmonella strains with MICs as low as 0.125 µg/mL. The extracts showed no cytotoxicity, suggesting they are safe and promising for developing treatments against MDR Salmonella infections.
21. Diop et al. developed a wound dressing with a blend of avocado and mango kernel extracts, which effectively inhibited 36 bacterial strains, especially *Staphylococcus aureus*. The blend had a lower MIC (0.019 mg/mL) than individual extracts. The final dressing, incorporating non-woven fabric and a swelling gel, demonstrated strong antibacterial activity.
22. Yogeswara et al. found that hexane, ethyl acetate, and 50% aqueous methanol extracts from *Blumea balsamifera* leaves effectively inhibited *E. coli* O157. *Pseudomonas aeruginosa*, and *Bacillus cereus*. Ethyl acetate.
23. Ahmadi et al. developed chitosan-based membranes integrated with thyme and garlic extracts, modifying polyethersulfone (PES) membranes. The thyme (TE-CS) and garlic (GE-CS) membranes showed significant antibacterial activity and improved pure water flux, with garlic increasing flux and both extracts enhancing chemical oxygen demand removal. TE-CS/PES had the best rejection and antifouling properties, suggesting promising applications for antibacterial materials.
24. Agbebi et al. investigated peptide-rich extracts from Nigerian plants, revealing that *Nauclea diderichii* had the highest antimicrobial potency with MICs of 7.8 µg/mL against bacteria and fungi. Extracts from *Euphorbia hirta* and *Nauclea diderichii* exhibited broad-spectrum bactericidal activity, highlighting their potential as effective antimicrobial agents.
25. Amini et al. studied the phytochemical profiling and antibacterial properties of *Calotropis procera* extracts from twigs, leaves, and flowers. Methanolic extracts were effective against both Gram-positive and Gram-negative bacteria, with zones of inhibition between 8.5 and 12.5 mm. MIC and MBC values ranged from 5–40 mg/mL. HPLC analysis indicated polar phytochemicals contribute to the antibacterial activity, suggesting further research into the plant's antimicrobial potential.
26. Elchaghaby et al. assessed lemongrass, sage, and guava leaf extracts for antibacterial activity against *Streptococcus mutans*. The extracts, rich in antioxidants, phenols, and flavonoids, demonstrated strong antibacterial, anti-inflammatory, and anticancer properties. The study recommends using these extracts in oral care products to improve dental health and manage infections.
27. Khan et al. studied *Primula* species in the Western Himalayas, focusing on their ethnobotanical uses and antibacterial properties. Through interviews and lab testing, they evaluated aqueous, methanol, ethanol, acetone, and pet ether extracts from various plant parts. Notable antibacterial activity was observed, particularly in *P. denticulata*, against *Bacillus cereus*, *Escherichia coli*, *Achromobacter xyloxidans*, and *Pseudomonas aeruginosa*. Extracts with MIC ≤0.125 mg/mL were highly effective, bridging traditional knowledge with scientific validation.
28. Adetutu et al. evaluated *Bridelia ferruginea* leaf extracts for antibacterial, antioxidant, and fibroblast growth effects. The ethanolic extract showed weak antibacterial activity (MIC > 470 µg/mL) but significantly stimulated fibroblast growth and provided high protection against H_2O_2 damage, with an IC50 of 12.5 µg/mL for antioxidant activity.
29. Bridelia ferruginea decoctions are widely used in Africa to address infections from *Escherichia coli*, *Staphylococcus*, *haemolytic streptococci*, *Bacillus*, *Pseudomonas*, and *Proteus* species, which can delay wound healing. Traditional uses, combined with scientific evidence of its antibacterial and antioxidant properties, underscore its potential in infection management and wound care.

30. In the study by Mohammad Amzad Hossain et al., *Haplophyllum tuberculatum* was evaluated for its medicinal properties. Traditionally used for various ailments, the plant showed significant antibacterial activity against both Gram-positive and Gram-negative bacteria, with inhibition zones up to 20 mm. It also demonstrated strong antioxidant activity across all concentrations. These findings highlight *H. tuberculatum*'s potential for treating infections and providing antioxidant support.
31. Rambaran et al. investigated *Embelia ruminata* extracts for antibacterial and anti-quorum sensing (QS) activities. The extracts showed significant antibacterial effects against methicillin-resistant *Staphylococcus aureus* and inhibited QS, particularly in methanolic seed extracts. This suggests *E. ruminata* may be effective against resistant bacteria and QS-related infections.
32. Amir Ahmadi et al. assessed the stability and antibacterial properties of alfalfa-extracted chlorophyll. Optimal extraction conditions were 50 mM NaCl, -18 °C, pH 4.5, and 15 days. The chlorophyll showed varying antibacterial effects, with Listeria being least resistant and Pseudomonas most resistant, indicating potential for use in food and health industries.
33. The study evaluated the antioxidant and antibacterial properties of six native Argentine woody species: Aspidosperma quebracho-blanco, Sarcomphalus mistol, Geoffroea decorticans, Prosopis chilensis, Larrea divaricata, and Larrea cuneifolia. Larrea and S. mistol, rich in polyphenols, exhibited strong antioxidant and antibacterial activities against S. aureus and E. faecalis, indicating their potential for therapeutic and industrial applications.
34. A novel sesquiterpene lactone and twenty-one known compounds were identified in Centaurothamnus maximus. These compounds showed significant antibacterial and antifungal activities against B. subtilis, S. aureus, S. pyogenes, and C. albicans. The new sesquiterpene lactone and other compounds demonstrate C. maximus's potential as a source of antimicrobial agents.
35. The antibacterial efficacy of ε-polylysine and extracts from Thymus vulgaris, Zataria multiflora, and Salvia verticillata was tested against Pseudomonas aeruginosa and Pectobacterium carotovorum. Thymus vulgaris showed the lowest MIC and induced bacterial membrane damage. HPLC and NMR identified chlorogenic acid as a key component, highlighting its effectiveness.
36. Wang et al. investigated Thamnolia vermicularis (Tv) and Thamnolia subuliformis (Ts) for identification and antibacterial activity. Using three distinct methods for differentiation, the study compared endophytic fungi diversity and antibacterial properties of both species. The research clarifies species distinctions and explores their potential as antibacterial agents, enhancing understanding of these lichens.
37. Unissa Syed et al. studied the cold methanolic extract of Olea europaea leaves from Saudi Arabia for its bioactive compounds and antibacterial properties. GC–MS identified key compounds like 9,12-octadecadienoic acid and Vitamin E. The extract showed broad antibacterial activity, though less extensive than ciprofloxacin. Olive, known for its diverse health benefits, including managing blood sugar and cholesterol, also exhibits antibacterial potential, making it valuable for various therapeutic applications.
38. Liu et al. investigated the antibacterial and antibiofilm effects of the dichloromethane fraction (DCM) from Eurycoma longifolia adventitious roots. DCM showed strong activity against Staphylococcus aureus with a minimum inhibitory concentration of 0.25 mg/mL. It disrupted bacterial cell permeability, respiration, and biofilm structure, suggesting its potential in food and pharmaceutical applications.

39. Nengroo et al. studied Aconitum heterophylum, focusing on its fatty acid profile, antibacterial, and antioxidant activities. Extracts from seeds and roots, particularly methanol extracts, showed significant antibacterial and antioxidant effects. Gas chromatography identified linoleic acid as a major component. This research highlights A. heterophylum's medicinal potential, supporting further exploration of its therapeutic uses.
40. Xiang Li et al. investigated Rosa chinensis cv. 'JinBian' for anti-aging, anti-tyrosinase, and antibacterial properties. Both 95% and 65% ethanol extracts showed strong antioxidant, elastase inhibition, and anti-tyrosinase activities. A new compound, kaempferol 3-O-α-l-rhamnopyranosyl (1→6)-(2",3"-O-digalloyl)-β-d-glucopyranoside, and fourteen known compounds were isolated. This study underscores the potential of this rose cultivar in natural cosmetic and antibacterial applications.
41. Suneeta et al. enhanced cotton fabric's antibacterial properties using neem leaf extract as a dye. The study showed that neem extracts significantly improved antibacterial, anti-aging, and skin-whitening effects. The treated fabric demonstrated remarkable antibacterial activity, even after multiple wash cycles. This eco-friendly approach underscores neem's potential for developing textiles with improved hygiene and functionality.
42. Narayanan et al. evaluated methanol extract from Aerva lanata flowers, finding strong antibacterial activity against several pathogens, significant antioxidant properties, and a 97.04% nephroprotective effect at 20 µg/mL. Despite these benefits, the extract's cytotoxicity in HEK 293 cells suggests the need for further safety studies.
43. Henrique Santo et al. used pressurized liquid extraction (PLE) and supercritical fluid extraction (SFE) to obtain bioactive compounds from feijoa leaves. The SFE extract showed significant antibacterial activity against foodborne pathogens, with MIC values from 3,553 to 14,211 µg/mL, and contained key phenolics like gallic acid and catechin.
44. Narayanankutty et al. investigated essential oils from Curcuma amada (mango ginger) rhizomes for eco-friendly biocides. Extracted using hydrodistillation, steam distillation, microwave-assisted, and ultrasound-assisted methods, the oils showed varying antibacterial and larvicidal activities. UAE and MAE extracts were most effective, suggesting potential for natural, sustainable pest control and antibacterial applications.
45. Sivasamugham et al. studied the antibacterial effects of 80% ethanolic leaf extracts from Musa paradisiaca, Musa acuminata, and Musa sapientum against MRSA and MSSA. Extracts from M. paradisiaca and M. acuminata showed significant inhibition at 2.86g/mL and 3.33g/mL, respectively, attributed to phytochemicals like alkaloids and tannins. M. sapientum showed no activity. The study highlights the potential of Musa leaf extracts in combating antibiotic-resistant infections.
46. Jurić et al. evaluated peppermint extracts using natural deep eutectic solvents (NADES) versus 70% ethanol for phenolic content, antioxidant, and antibacterial activities. NADES extracted more phenols, including rosmarinic acid, and showed greater antibacterial and antioxidant effects than 70% ethanol. This suggests NADES as a sustainable, effective alternative for extracting bioactive compounds.
47. Zahan et al. investigated the methanol extract of Piper nigrum seeds, finding it more effective against methicillin-resistant Staphylococcus aureus (MRSA) than against extended-spectrum beta-lactamase (ESbL) producing Klebsiella pneumoniae. The extract demonstrated lower Minimum Inhibitory Concentration (MIC) values for MRSA, highlighting its potential as a natural antimicrobial agent and an alternative to address antibiotic-resistant strains.

48. Zhong et al. analyzed the polar antibacterial fraction from the ethanol extract of Rosmarinus officinalis, revealing stronger antibacterial activity against Bacillus subtilis compared to rosemary's essential oil. UPLC-OrbitrapMS/MS identified sixteen compounds, including two novel ones. The findings suggest the polar fraction's potential as a food additive due to its robust antibacterial properties.
49. M. Kaleng et al. studied biflavonoids from Ochna kirkii's root bark, identifying new compounds kirkinone A and B, and six known ones. Calodenin B and lophirone A showed significant antibacterial activity against Bacillus subtilis and cytotoxicity against MCF-7 breast cancer cells. The crude extract was cytotoxic but inactive against Escherichia coli. The study highlights the chemotaxonomic importance of these compounds in Ochna.
50. Nongma et al. investigated Piper wallichii stems and leaves, identifying two new compounds: piwalkanone (an aryl alkanone) and piwallidione (a dioxoaporphine alkaloid). They also isolated nine known compounds, including piperine and piperlonguminine. Structures were confirmed via spectroscopy and MS. Compounds piwallidione and cepharadione A showed antibacterial activity against Bacillus cereus, Bacillus subtilis, and Staphylococcus aureus.
51. Pouofo Nguiam et al. found that Xylopia staudtii, used traditionally in western Cameroon, has significant antibacterial and antishigellosis properties. The plant's bark effectively combats Shigella spp. and E. coli, reducing bacteria load in mice and preventing intestinal damage, highlighting its potential as a natural antimicrobial agent.
52. Citrus hystrix, used in Indonesian medicine, showed significant antibacterial activity against *Salmonella typhimurium*. The ethanolic peel extract had a minimum inhibitory concentration (MIC) of 0.625%. Infected mice treated with the extract exhibited reduced bacterial loads in the ileum, liver, and spleen, indicating its potential for treating Salmonella infections.
53. The study on Ethiopian Kale (*Brassica carinata*) leaves explored its phytochemical composition, antibacterial, and antioxidant properties. The ethanol extract showed significant antibacterial activity and antioxidant potential in DPPH* and ABTS assays. GC–MS analysis identified over 17 major phytocompounds. These findings highlight the functional potential of Ethiopian Kale leaves.
54. The study evaluated ethanolic guava leaf extracts with different chlorophyll removal processes for antibacterial and anti-melanosis effects on Pacific white shrimp. All extracts showed significant antibacterial and polyphenoloxidase inhibitory activities, with GLE-S being most effective. GLE-S, rich in compounds like piceatannol 4′-galloylglucoside, improved shrimp quality by reducing microbial and chemical changes during storage.
55. The study assessed the antibacterial efficacy of ethanolic guava leaf extracts (EGLE) with and without chlorophyll removal. For Gram-positive bacteria like *Staphylococcus aureus* and *Listeria monocytogenes*, MIC values ranged from 64 to 128 mg/ml, and MBC values from 256 to 512 mg/ml. For Gram-negative bacteria such as *Vibrio parahaemolyticus*, *Pseudomonas aeruginosa*, and *Escherichia coli*, MICs ranged from 32 to 64 mg/ml and MBCs from 32 to 256 mg/ml, indicating the extracts' strong antibacterial properties.
56. The study evaluated the antibacterial activity of Aronia melanocarpa anthocyanins (AMAs) against *Escherichia coli* (E. coli). AMAs demonstrated strong activity with a MIC of 0.625 mg/mL and an MBC of 1.25 mg/mL. They disrupt E. coli's cell wall and membrane, as confirmed by SEM and TEM, and interact with bacterial DNA. These findings suggest AMAs as potential natural food preservatives.
57. The study by Getahun et al. investigated oils from *Lepidium sativum* seeds extracted using different methods. The steam-distilled essential oil (EO) showed superior antibacterial activity against

Klebsiella pneumoniae, *Escherichia coli*, and *Bacillus cereus*, but not *Staphylococcus aureus*, at 1 mg/mL. It also exhibited significant antioxidant activity in DPPH and H2O2 assays.

58. Zhao et al. investigated the antibacterial activity of tea saponin from *Camellia oleifera* shells. The study found that tea saponin effectively inhibited *Escherichia coli* and *Staphylococcus aureus* with minimum inhibitory concentrations of 1 mg/mL and 0.5 mg/mL, respectively, and a minimum bactericidal concentration of 4 mg/mL. The saponin disrupted bacterial cell membranes and growth, suggesting its potential as a natural antibacterial agent and a valuable use for camellia tea waste.
59. González-Renteria et al. evaluated *Lemna minor* extracts against *Pseudomonas fluorescens* using methanol, chloroform, and hexane. Hexane extract exhibited the highest antibacterial activity, with significant differences among extracts (p=0.001). Methanol had an MIC of 0.05 µg/mL and showed better safety in embryos and larvae, indicating potential for antibacterial applications.
60. Marsoul et al. studied *Papaver rhoeas* flower extracts using methanolic maceration and Soxhlet methods. Soxhlet extracts had higher total phenolic content (165.4 mg GAE/g) and antioxidant activity (IC50=3.81 mg/mL) compared to maceration. Both methods showed antibacterial potential, with Soxhlet extract being particularly effective against *Enterococcus faecalis* (MIC=0.11 mg/mL).
61. Zhang et al. studied a formulation with polyprenol extracted from *Ginkgo biloba* leaves. This formulation showed significant antibacterial and antifungal activity against *Staphylococcus aureus*, *Escherichia coli*, *Candida albicans*, and *Streptococcus pneumoniae*, with MIC values ranging from 25 to 200 µg/mL. The results highlight its potential as a broad-spectrum antibacterial agent.
62. Nocedo-Mena et al. investigated sphingolipids and other compounds from *Cissus incisa* leaves, known in Mexican medicine. The study confirmed its traditional use by showing significant antibacterial activity against Gram-positive and Gram-negative bacteria and notable cytotoxic effects on PC3 and Hep3B cancer cell lines. This highlights the plant's potential in drug discovery
63. Souiss et al. examined cardamom (Elettaria cardamomum) extracts for their antibacterial and anti-inflammatory properties against periodontal pathogens. Both fruit and seed extracts showed effective antibacterial action, disrupting *Porphyromonas gingivalis* membranes and inhibiting biofilm formation. They also reduced inflammatory cytokine secretion, suggesting potential therapeutic use against periodontal infections.
64. Asgharpour et al. analyzed the hexane extract of *Lycoperdon pyriforme* and found significant antibacterial activity against *Staphylococcus aureus*, with Ergosta-5,7-dien-3-ol being the primary compound. Effective at 125 µg/mL, the study highlights bioactive compounds like polysaccharides, alkaloids, and terpenoids, supporting mushrooms' potential as antibacterial agents.
65. Anderson Ngandjui Tchangoue et al. assessed phloroglucinol derivatives from *Mallotus oppositifolius* leaves, finding MIC values from 3.125 to 50 µg/mL against *E. coli*, *S. aureus*, *S. typhi*, and *P. aeruginosa*. The plant, traditionally used for various ailments, shows promising antibacterial properties.
66. The study assessed the antibacterial properties of compounds from *Ficus auriculata* fruits using serial dilution in 96-well plates. Testing against five bacterial strains revealed significant activity, particularly from compound 1, with MIC values as low as 1.25 µg/mL. Compound 4 also showed effectiveness. The findings support the potential of these compounds as antimicrobial agents.
67. Wang et al. investigated sesquiterpenes from *Thuja sutchuenensis* stems and roots for their antibacterial properties. The sesquiterpenes showed significant activity against various bacteria,

including methicillin-resistant *Staphylococcus aureus*, with MICs ranging from 6.25 to 25 µg/mL. These findings highlight their potential as novel antimicrobial agents.

68. Feng He et al. investigated the antioxidant and antibacterial properties of essential oil from *Atractylodes lancea* rhizomes. The oil showed significant antibacterial activity against several bacterial strains, likely due to its impact on cell membrane integrity. Additionally, it demonstrated notable antioxidant activity, highlighting its potential for pharmaceutical and food preservation applications.
69. Anderson Ngandjui Tchangoue et al. investigated the antibacterial potential of phloroglucinol derivatives from *Mallotus oppositifolius* leaves. They used CHCl3/MeOH and EtOH/H2O solvent systems for extraction from air-dried and macerated leaves. The study focuses on phloroglucinols, known for their diverse biological activities, to explore natural antibacterial agents.
70. Cong Wu et al. investigated new oxylipins from *Siegesbeckia glabrescens*, a plant used in Chinese medicine for various ailments. They identified these rare compounds in the ethanolic extract of the plant, suggesting their potential as antibacterial agents. This study highlights the chemical diversity of *Siegesbeckia* and its potential therapeutic applications.
71. Tiwana et al. evaluated *Triphala—Terminalia bellirica*, *Terminalia chebula*, and *Emblica officinalis*—for antibacterial effects using methanolic and aqueous extracts. Methanolic extracts showed higher potency with MICs of 250–750 µg/mL. Terminalia chebula was most effective, clarifying inconsistencies in previous antimicrobial reports and emphasizing *Triphala*'s potential.
72. Li Yan et al. investigated the antibacterial and antibiofilm effects of *Trollius altaicus* flower extracts against *Streptococcus mutans*. The study found that water, ethanol, and n-butanol extracts had MIC values of 10, 5, and 10 mg/mL, and MBC values of 20, 10, and 20 mg/mL, respectively. The extracts significantly inhibited biofilm formation and disrupted existing biofilms, suggesting potential for dental caries treatment.
73. Techaoei et al. investigated bioactive compounds from endophytic fungi in *Nelumbo nucifera* for their antibacterial effects against MRSA. Isolates from various plant parts, especially the root, were analyzed for their chemical properties and antibacterial activity. This research aims to find novel agents to combat antibiotic-resistant MRSA.
74. Linden et al. investigated biflavonoids from Brazilian peppertree fruits for antibacterial properties. Tetrahydroamentoflavone (THAF) was the most effective, showing activity against both planktonic cells and biofilms. Structural features, like flavonoid linkage and C-ring saturation, were crucial for antibacterial efficacy, highlighting THAF's potential in antimicrobial development.
75. Siwe-Noundou et al. investigated Alchornea laxiflora's extracts and isolated compounds for biological activity. The methanolic stem extract contained ellagic acid and other compounds. The root extract showed significant anti-HIV activity, while extracts and compounds displayed potent antibacterial effects, especially against Staphylococcus saprophyticus with MICs as low as 4 µg/ml. All samples had low cytotoxicity.
76. Barbosa et al. explored the extraction of antibacterial compounds from Hancornia speciosa leaves using pressurized liquid extraction. The purified extract showed significant activity against multidrug-resistant E. coli. The study highlights the importance of extraction methods and solvents in isolating bioactive phenolic compounds, emphasizing their potential therapeutic applications.
77. The study by Tian et al. investigates the extraction and analysis of flavonoids from Tribulus terrestris L. leaves, optimized with 25.87% ethanol. The research evaluates their antioxidant, antibacterial,

analgesic, and anti-inflammatory activities, highlighting the plant's traditional uses for eye issues, pruritus, chest pain, hypoimmunity, and cerebral diseases.

78. Hou et al. investigated the antibacterial properties of essential oil extracted from Citrus reticulate Blanco peel. The oil demonstrated significant antibacterial activity against Cutibacterium acnes and other microbes like Staphylococcus aureus, Bacillus subtilis, and Escherichia coli. Its effectiveness against Cutibacterium acnes surpassed common antibiotics, suggesting its potential as an alternative or complementary treatment for acne.
79. Chabán et al. studied the antibacterial effects of Lepechinia meyenii extracts, isolating abietane compounds carnosol, rosmanol, and carnosic acid. These compounds showed MIC values of 15.6–62.5 µg/mL against MRSA and 15.6–31.2 µg/mL against MSSA, with significant activity against Enterococcus faecalis. The study highlights their potential as effective agents against drug-resistant bacteria.
80. Bilal et al. evaluated the antibacterial activity of Suaeda maritima extracts against Gram-positive and Gram-negative bacteria. The hexane extract exhibited the highest activity, suggesting its potential for treating infections and highlighting the plant's promise as a medicinal resource for various bacterial strains.

REFERENCE

1. Nguyen TP, Phan HN, Do TD, et al. Polysaccharide and ethanol extracts of Anoectochilus formosanus Hayata: Antioxidant, wound-healing, antibacterial, and cytotoxic activities. *Heliyon*. 2023;9(3):e13559. doi:10.1016/j.heliyon.2023.e13559
2. Ahmed SN, Al Touby SS, Hossain MA. Isolation and evaluation of significant antibacterial fraction of methanol and its derived fractions from the leaves extract of Zygophyllum simplex. *Adv Biomark Sci Technol*. 2023;5(January):1-7. doi:10.1016/j.abst.2023.01.001
3. Prabhu Teja P, Hemanth Rao K, Rishi Kumar K, Baji Babu K, Kubera Sampath Kumar S, Vijetha P. Extraction of eco-friendly biocomposites from eulaliopsis binata: Mechanical, thermal and anti-bacterial studies. *Mater Today Proc*. 2023;72:81-85. doi:10.1016/j.matpr.2022.06.091
4. Mehrabani M, Amirkhosravi A, Farhadi S, Vasei S, Raeiszadeh M. Annales Pharmaceutiques Françaises The influence of harvest time on total phenolic and flavonoid contents , antioxidant , antibacterial and cytotoxicity of Rheum khorasanicum root extract L ' influence du moment de la récolte sur les teneurs totales en ph. 2023;81(3):1-7.
5. Ibrahim Alghamdi A. Antibacterial activity of green tea leaves extracts against specific bacterial strains. *J King Saud Univ - Sci*. 2023;35(5). doi:10.1016/j.jksus.2023.102650
6. Kuete V, Fankam AG. Phytochemistry and antibacterial potential of the genus Fagara. *Adv Bot Res*. 2023;107:67-104. doi:10.1016/bs.abr.2022.08.013
7. Meryem S, Mohamed D, Nour-eddine C, Faouzi E. Chemical composition, antibacterial and antioxidant properties of three Moroccan citrus peel essential oils. *Sci African*. 2023;20. doi:10.1016/j.sciaf.2023.e01592
8. Sopovski DS, Han J, Stevens-Riley M, et al. Investigation of microorganisms in cannabis after heating in a commercial vaporizer. *Front Cell Infect Microbiol*. 2023;12. doi:10.3389/fcimb.2022.1051272
9. 9,23.pdf.
10. 10,23.pdf.
11. 11,23.pdf.

12. Aljarbou F, Almobarak A, Binrayes A, Alamri HM. Salvadora persica's Biological Properties and Applications in Different Dental Specialties: A Narrative Review. *Evid Based Complement Alternat Med*. 2022;2022. doi:10.1155/2022/8667687
13. 13,23.pdf.
14. 14,23.pdf.
15. 15,23.pdf.
16. 16,23.pdf.
17. 17,23.pdf.
18. Moliva MV, Cariddi LN, Pereyra ER, et al. Evaluation of antibacterial and antibiofilm properties of Minthostachys verticillata essential oils against bovine Staphylococcus aureus strains. *Biocatal Agric Biotechnol*. 2023;50(July):1-6. doi:10.1016/j.bcab.2023.102697
19. Nuñez L, D'Aquino M. Microbicide activity of clove essential oil (Eugenia Caryophyllata). *Brazilian J Microbiol*. 2012;43(4):1255-1260. doi:10.1590/S1517-83822012000400003
20. Akongwi M, Kwene EC, Awah LA, et al. Anti-Salmonella activity on multidrug-resistant strains and cytotoxicity of extracts and constituents of Garcinia brevipedicellata and Garcinia epunctata. *Sci African*. 2023;19. doi:10.1016/j.sciaf.2022.e01465
21. 2.1海上位置測量, 2.2海岸地形. *J Fish Eng*. 1985;22(extra):28-37.
22. Agung Yogeswara IB, Ayu Wita Kusumawati IG, Nursini NW. Antibacterial activity and cytotoxicity of sequentially extracted medicinal plant Blumea balsamifera Lin. (DC). *Biocatal Agric Biotechnol*. 2022;43(August):1-6. doi:10.1016/j.bcab.2022.102395
23. Ahmadi H, Jahanshahi M, Peyravi M, Darzi GN. A new antibacterial insight of herbal chitosan-based membranes using thyme and garlic medicinal plant extracts. *J Clean Prod*. 2022;334(February):1-8. doi:10.1016/j.jclepro.2021.130114
24. Agbebi EA, Alabi OS, Nkrumah AO, Ogbole OO. Evaluation of the antibacterial and antifungal potentials of peptide-rich extracts from selected Nigerian plants. *Eur J Integr Med*. 2022;54(September):1-7. doi:10.1016/j.eujim.2022.102163
25. 26,22.
26. Elchaghaby MA, Abd El-Kader SF, Aly MM. Bioactive composition and antibacterial activity of three herbal extracts (lemongrass, sage, and guava leaf) against oral bacteria: An in vitro study. *J Oral Biosci*. 2022;64(1):114-119. doi:10.1016/j.job.2022.01.005
27. 28,22.
28. Ahmad N, Muhammad J, Khan K, et al. Silver and gold nanoparticles induced differential antimicrobial potential in calli cultures of Prunella vulgaris. *BMC Chem*. 2022;16(1). doi:10.1186/s13065-022-00816-y
29. Agour A, Mssillou I, Es-safi I, et al. The Antioxidant, Analgesic, Anti-Inflammatory, and Wound Healing Activities of Haplophyllum tuberculatum (Forsskal) A. Juss Aqueous and Ethanolic Extract. *Life*. 2022;12(10). doi:10.3390/life12101553
30. Rambaran N, Naidoo Y, Mohamed F, Chenia HY, Baijnath H. Antibacterial and anti-quorum sensing activities of the different solvent extracts of Embelia ruminata. *South African J Bot*. 2022;151(December):996-1007. doi:10.1016/j.sajb.2022.11.014
31. 33.
32. Lorenzo ME, Casero CN, Gómez PE, et al. Antioxidant characteristics and antibacterial activity of native woody species from Catamarca, Argentina. *Nat Prod Res*. 2022;36(4):885-890.

doi:10.1080/14786419.2020.1839461
33. Al-Saleem MSM, Al-Wahaibi LH, El-Gamal AA, et al. Chemical constituents from Centaurothamnus maximus and their antimicrobial activity. *Nat Prod Res*. 2023;37(5):693-701. doi:10.1080/14786419.2022.2079123
34. Bandian L, Moghaddam M, Bahreini M, Vatankhah E. Antibacterial characteristics and mechanisms of some herbal extracts and ϵ-polylysine against two spoilage bacterial. *Food Biosci*. 2022;50(December):2022-2024. doi:10.1016/j.fbio.2022.102060
35. Wang J, Zhao H, Guo Q, Ding H. Identification and antibacterial activity of Thamnolia vermicularis and Thamnolia subuliformis. *J Microbiol Methods*. 2022;203(December):1-5. doi:10.1016/j.mimet.2022.106628
36. Sudjana AN, D'Orazio C, Ryan V, et al. Antimicrobial activity of commercial Olea europaea (olive) leaf extract. *Int J Antimicrob Agents*. 2009;33(5):461-463. doi:10.1016/j.ijantimicag.2008.10.026
37. Hao Y, Guo X, Zhang W, et al. Label-free quantitative proteomics reveals the antibacterial mechanism of rosemary essential oil against Salmonella enterica serovar Typhimurium. *Ind Crops Prod*. 2022;189(December):2-7. doi:10.1016/j.indcrop.2022.115757
38. Hussain MJ, Abbas Y, Nazli N, et al. Root Cultures, a Boon for the Production of Valuable Compounds: A Comparative Review. *Plants*. 2022;11(3). doi:10.3390/plants11030439
39. Nengroo ZR, Ganie AS, Azeem M. Aconitum heterophylum from Kashmir: Evaluation of fatty acid profile, antibacterial, antioxidant activities and functional group analysis. *Carbohydr Polym Technol Appl*. 2021;2(December):1-20. doi:10.1016/j.carpta.2021.100105
40. 42,21.pdf.
41. Stafstrom CE, Carmant L. Seizures and epilepsy: An overview for neuroscientists. *Cold Spring Harb Perspect Biol*. 2015;7(5):1-19. doi:10.1101/cshperspect.a022426
42. Behera P, Ghosh M. Evaluation of antioxidant, antimicrobial, and antiurolithiatic potential of different solvent extracts of Aerva lanata linn flowers. *Pharmacogn Mag*. 2018;14(53):53-57. doi:10.4103/pm.pm_60_17
43. Santos PH, Kammers JC, Silva AP, Oliveira JV, Hense H. Antioxidant and antibacterial compounds from feijoa leaf extracts obtained by pressurized liquid extraction and supercritical fluid extraction. *Food Chem*. 2021;344(May):2021-2023. doi:10.1016/j.foodchem.2020.128620
44. Narayanankutty A, Sasidharan A, Job JT, et al. Mango ginger (Curcuma amada Roxb.) rhizome essential oils as source of environmental friendly biocides: Comparison of the chemical composition, antibacterial, insecticidal and larvicidal properties of essential oils extracted by different methods. *Environ Res*. 2021;202(November):1-7. doi:10.1016/j.envres.2021.111718
45. Sivasamugham LA, Nimalan V, Subramaniam G. Antibacterial effects of Musa sp. ethanolic leaf extracts against methicillin-resistant and susceptible Staphylococcus aureus. *South African J Chem Eng*. 2021;35(January):107-110. doi:10.1016/j.sajce.2020.09.007
46. Jurić T, Mićić N, Potkonjak A, et al. The evaluation of phenolic content, in vitro antioxidant and antibacterial activity of Mentha piperita extracts obtained by natural deep eutectic solvents. *Food Chem*. 2021;362(November):2021-2023. doi:10.1016/j.foodchem.2021.130226
47. Rachdi H, Mokrani A, Batti R, Ayadi M, Chraiet N, Mezlini A. Target therapy for metastatic breast cancer. *Tunisie Medicale*. 2018;96(8):465-471. doi:10.5003/2151-4194.1.3.565
48. Narayanan M, Krishnan L, Natarajan D, et al. Evaluation of antibacterial, antioxidant, and nephroprotective proficiency of methanol extract of Aerva lanata. *Process Biochem*.

2021;109(October):98-103. doi:10.1016/j.procbio.2021.07.004
49. Lin PC, Wang X, Zhong XJ, et al. Chemical characterization of a PD-1/PD-L1 inhibitory activity fraction of the ethanol extract from Gymnadenia conopsea. *J Asian Nat Prod Res*. 2021;23(3):235-249. doi:10.1080/10286020.2020.1844190
50. Kalenga TM, Ndoile MM, Atilaw Y, et al. Biflavanones, Chalconoids, and Flavonoid Analogues from the Stem Bark of Ochna holstii. *J Nat Prod*. 2021;84(2):364-372. doi:10.1021/acs.jnatprod.0c01017
51. Nongmai C, Kanokmedhakul K, Promgool T, Paluka J, Suwanphakdee C, Kanokmedhakul S. Chemical constituents and antibacterial activity from the stems and leaves of Piper wallichii. *J Asian Nat Prod Res*. 2022;24(4):344-352. doi:10.1080/10286020.2021.1933959
52. Pouofo Nguiam M, Njonte Wouamba SC, Longo F, et al. Antibacterial and antishigellosis activity of Xylopia staudtii (engl. & diels), Annonaceae. *J Ethnopharmacol*. 2021;280(November):1-7. doi:10.1016/j.jep.2021.114406
53. Ulhaq ZS, Hendyatama TH, Hameed F, Santosaningsih D. Enfermedades infecciosas y microbiologia clinica (English ed .) Antibacterial activity of Citrus hystrix toward Salmonella spp . infection Actividad antibacteriana de Citrus hystrix frente a la infección por Salmonella spp. 2021;39(6):283-286.
54. Murugesan K, Mulugeta K, Hailu E, Tamene W, Alagar Yadav S. Insights for integrative medicinal potentials of Ethiopian Kale (Brassica carinata): Investigation of antibacterial, antioxidant potential and phytocompounds composition of its leaves. *Chinese Herb Med*. 2021;13(2):250-254. doi:10.1016/j.chmed.2020.09.003
55. Deng H, Zhu J, Tong Y, et al. Antibacterial characteristics and mechanisms of action of Aronia melanocarpa anthocyanins against Escherichia coli. *Lwt*. 2021;150(June):112018. doi:10.1016/j.lwt.2021.112018
56. Elchaghaby MA, Abd El-Kader SF, Aly MM. Bioactive composition and antibacterial activity of three herbal extracts (lemongrass, sage, and guava leaf) against oral bacteria: An in vitro study. *J Oral Biosci*. 2022;64(1):114-119. doi:10.1016/j.job.2022.01.005
57. Abdulsattar AM, Hossain MA. Antibacterial and antioxidant potential of Tetraena simplex extracts of various polarities. *Toxicol Reports*. 2020;7:925-929. doi:10.1016/j.toxrep.2020.07.014
58. Getahun T, Sharma V, Gupta N. Chemical composition, antibacterial and antioxidant activities of oils obtained by different extraction methods from Lepidium sativum L. seeds. *Ind Crops Prod*. 2020;156(November):1-9. doi:10.1016/j.indcrop.2020.112876
59. Zhao Y, Su R, Zhang W, Yao GL, Chen J. Antibacterial activity of tea saponin from Camellia oleifera shell by novel extraction method. *Ind Crops Prod*. 2020;153(October):1-7. doi:10.1016/j.indcrop.2020.112604
60. González-Renteria M, del Carmen Monroy-Dosta M, Guzmán-García X, Hernández-Calderas I, Ramos-Lopez y. MA. Antibacterial activity of Lemna minor extracts against Pseudomonas fluorescens and safety evaluation in a zebrafish model. *Saudi J Biol Sci*. 2020;27(12):3465-3473. doi:10.1016/j.sjbs.2020.09.043
61. Marsoul A, Ijjaali M, Oumous I, Bennani B, Boukir A. Determination of polyphenol contents in Papaver rhoeas L. Flowers extracts (Soxhlet, maceration), antioxidant and antibacterial evaluation. *Mater Today Proc*. 2020;31:S183-S189. doi:10.1016/j.matpr.2020.08.082
62. Zhang CW, Li MF, Tao R, et al. Physiochemical property and antibacterial activity of formulation containing polyprenol extracted from Ginkgo biloba leaves. *Ind Crops Prod*. 2020;147(May):1-8.

doi:10.1016/j.indcrop.2020.112213

63. Nocedo-Mena D, Garza-González E, González-Ferrara M, del Rayo Camacho-Corona M. Antibacterial Activity of Cissus incisa Extracts against Multidrug- Resistant Bacteria. *Curr Top Med Chem*. 2019;20(4):318-323. doi:10.2174/1568026619666191121123926
64. Souissi M, Azelmat J, Chaieb K, Grenier D. Antibacterial and anti-inflammatory activities of cardamom (Elettaria cardamomum) extracts: Potential therapeutic benefits for periodontal infections. *Anaerobe*. 2020;61(February):1-7. doi:10.1016/j.anaerobe.2019.102089
65. Zhirnov AA, Kudryashova NN, Kudryashova OB, Korovina N V., Pavlenko AA, Titov SS. Spores of puffball fungus Lycoperdon pyriforme as a reference standard of stable monodisperse aerosol for calibration of optical instruments. *PLoS One*. 2019;14(1). doi:10.1371/journal.pone.0210754
66. Tchangoue YAN, Tchamgoue J, Lunga PK, et al. Antibacterial phloroglucinols derivatives from the leaves of Mallotus oppositifolius (Geisler) Müll. Arg. (Euphorbiaceae). *Fitoterapia*. 2020;142(April):3-8. doi:10.1016/j.fitote.2020.104527
67. Shao TM, Liao HX, Li XB, Chen GY, Song XP, Han CR. A new isoflavone from the fruits of Ficus auriculata and its antibacterial activity. *Nat Prod Res*. 2022;36(5):1191-1196. doi:10.1080/14786419.2020.1864368
68. Wang M, Zhao L, Chen K, et al. Antibacterial sesquiterpenes from the stems and roots of Thuja sutchuenensis. *Bioorg Chem*. 2020;96(March):1-6. doi:10.1016/j.bioorg.2020.103645
69. He F, Wang W, Wu M, et al. Antioxidant and antibacterial activities of essential oil from Atractylodes lancea rhizomes. *Ind Crops Prod*. 2020;153(October):1-7. doi:10.1016/j.indcrop.2020.112552
70. Tchangoue YAN, Tchamgoue J, Lunga PK, et al. Antibacterial phloroglucinols derivatives from the leaves of Mallotus oppositifolius (Geisler) Müll. Arg. (Euphorbiaceae). *Fitoterapia*. 2020;142(April):2-7. doi:10.1016/j.fitote.2020.104527
71. Wu C, Zhang Q, Yang F, et al. New oxylipins from Siegesbeckia glabrescens as potential antibacterial agents. *Fitoterapia*. 2020;145(September):1-6. doi:10.1016/j.fitote.2020.104613
72. Tiwana G, Cock IE, White A, Cheesman MJ. Use of specific combinations of the triphala plant component extracts to potentiate the inhibition of gastrointestinal bacterial growth. *J Ethnopharmacol*. 2020;260(October):1-9. doi:10.1016/j.jep.2020.112937
73. Yan L, Wu W, Tian S. Antibacterial and antibiofilm activities of Trollius altaicus C. A. Mey. On Streptococcus mutans. *Microb Pathog*. 2020;149(December):1-7. doi:10.1016/j.micpath.2020.104265
74. Yang H, He S, Feng Q, et al. Lotus (Nelumbo nucifera): a multidisciplinary review of its cultural, ecological, and nutraceutical significance. *Bioresour Bioprocess*. 2024;11(1). doi:10.1186/s40643-024-00734-y
75. Linden M, Brinckmann C, Feuereisen MM, Schieber A. Corrigendum to "Effects of structural differences on the antibacterial activity of biflavonoids from fruits of the Brazilian peppertree (Schinus terebinthifolius Raddi)" [Food Research International 133 (2020) 109134](S0963996920301599)(10.1016/j.foodres. *Food Res Int*. 2021;143(July 2020):1-4. doi:10.1016/j.foodres.2020.109561
76. Appraising the therapeutical potentials of Alchornea laxiflora (Benth.
77. Vij T, Anil PP, Shams R, et al. A Comprehensive Review on Bioactive Compounds Found in Caesalpinia sappan. *Molecules*. 2023;28(17). doi:10.3390/molecules28176247
78. Barbosa AM, Santos KS, Borges GR, et al. Separation of antibacterial biocompounds from Hancornia speciosa leaves by a sequential process of pressurized liquid extraction. *Sep Purif Technol*.

2019;222(September):390-395. doi:10.1016/j.seppur.2019.04.022

79. Al-Bayati FA, Al-Mola HF. Antibacterial and antifungal activities of different parts of Tribulus terrestris L. growing in Iraq. *J Zhejiang Univ Sci B*. 2008;9(2):154-159. doi:10.1631/jzus.B0720251
80. Gao P, Zheng M, Lu H, Lu S. The Progressive Utilization of Ponkan Peel Residue for Regulating Human Gut Microbiota through Sequential Extraction and Modification of Its Dietary Fibers. *Foods*. 2023;12(22). doi:10.3390/foods12224148
81. Chabán MF, Karagianni C, Joray MB, et al. Antibacterial effects of extracts obtained from plants of Argentina: Bioguided isolation of compounds from the anti-infectious medicinal plant Lepechinia meyenii. *J Ethnopharmacol*. 2019;239(July):1-8. doi:10.1016/j.jep.2019.111930
82. Dafallah Bilal MA, Hossain MA. Antibacterial activity of different crude extracts of Suaeda maritima used traditionally for the treatment of hepatitis. *Biocatal Agric Biotechnol*. 2019;22(November):1-8. doi:10.1016/j.bcab.2019.101383
83. Dhanasekaran S, Rajesh A, Mathimani T, Melvin Samuel S, Shanmuganathan R, Brindhadevi K. Efficacy of crude extracts of Clitoria ternatea for antibacterial activity against gram negative bacterium (Proteus mirabilis). *Biocatal Agric Biotechnol*. 2019;21(September):1-7. doi:10.1016/j.bcab.2019.101328
84. Divya Kumari P, Shenoy SM, Khijmatgar S, Chowdhury A, Lynch E, Chowdhury CR. Antibacterial activity of new atraumatic restorative treatment materials incorporated with Azadirachta indica (Neem) against Streptococcus mutans. *J Oral Biol Craniofacial Res*. 2019;9(4):321-325. doi:10.1016/j.jobcr.2019.06.014
85. Vazirzadeh A, Jalali S, Farhadi A. Antibacterial activity of Oliveria decumbens against Streptococcus iniae in Nile tilapia (Oreochromis niloticus) and its effects on serum and mucosal immunity and antioxidant status. *Fish Shellfish Immunol*. 2019;94(November):407-416. doi:10.1016/j.fsi.2019.09.025
86. Jiang S, Chen CF, Ma XP, et al. Antibacterial stilbenes from the tubers of Bletilla striata. *Fitoterapia*. 2019;138(October):1-7. doi:10.1016/j.fitote.2019.104350
87. Jalalvand AR, Zhaleh M, Goorani S, et al. Chemical characterization and antioxidant, cytotoxic, antibacterial, and antifungal properties of ethanolic extract of Allium Saralicum R.M. Fritsch leaves rich in linolenic acid, methyl ester. *J Photochem Photobiol B Biol*. 2019;192(March):103-112. doi:10.1016/j.jphotobiol.2019.01.017
88. Zafar S, Ur-Rehman F, Shah ZA, et al. Potent leishmanicidal and antibacterial metabolites from Olea ferruginea. *J Asian Nat Prod Res*. 2019;21(7):679-687. doi:10.1080/10286020.2018.1467894