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A Review Of Chemical Compounds And Bioactivity Of *Conyza* Species

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Abstract
A large proportion of the African population's primary healthcare requirements are still mostly met by traditional medicine. Previous studies have demonstrated the potential of plant extracts disease management. Conyza species are traditionally used for a variety of pharmacological applications including treatment of malaria, smallpox, chickenpox, sore throat, ringworm and other skin related infections, toothache and wounds. The aim of this study was to provide a review of the chemical compounds from Conyza species and their bioactivities. Extracts from Conyza species have a wide range of bioactivities including antioxidant, anti-inflammatory, antimicrobial, antitumor, analgesic, antiplasmodial, wound healing, insecticidal, allopathic, antidiabetic, antiviral, anticonvulsant and anti-amnesic effects. These bioactivities are attributed to the bioactive secondary metabolite including terpenoids, phenolic acids, flavonoids and tannins, saponins and steroids which are biosynthesized by the plants. Previous phytochemical test have shown that Conyza species are rich in alkaloids. However, the information about the alkaloids previously isolated from Conyza species is scanty in literature. Further studies should be done isolate and characterize the alkaloids from the plants.

Keywords: *Conyza species: Chemical compounds; Bioactivities*

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I. Introduction

Utilization of medicinal plants for disease management has been practiced for several thousands of years. A large proportion of the world population especially in Africa still rely on traditional medicines based on herbal plants for primary healthcare[1-3]. Previous phytochemical studies have led to identification of a wide range of chemical compounds including terpenoids, alkaloids, steroids, flavonoids and quinones[4-16]. Some of the compounds have demonstrated significant toxicity to disease causing microorganisms[17-24]. Despite the availability of conventional anti-infective agents, continued search for novel bioactive compounds from plants is unavoidable since most of the synthetic drugs have limitations in terms of side effects, drug resistance and non-biodegradability[25,26]. Anti-infective agents from natural origin have no side effects, have better patient tolerance and are readily available[27-29]. In addition chances of developing drug resistance is low. In recent years, many researchers have focused on authenticating the efficacy of medicinal plant extracts through *in-vivo* and in-vitro experiments, and isolation and structural determination of the bioactive compounds[30-35]. Such biologically active compounds represent an important source of drugs in the process of developing new pharmacologically active compounds[36-39].

Genus *Conyza* which belongs to the family Asteraceae comprises about 50 species, which are found in the tropical and warm regions. *Conyza* species are traditionally used for a variety of pharmacological applications including treatment of malaria, smallpox, chickenpox, sore throat, ringworm and other skin related infections, toothache and wounds[40]. The aim of this study was to provide a review of the chemical compounds from Conyza species and their bioactivities.

II. *Conyza* species compounds and bioactivities

Extracts from *Conyza* species have been subjected to *in-vitro* and *in-vivo* bioassays which have revealed the presence of a wide range of bioactivities including antioxidant[41-43] anti-inflammatory[44,45], antimicrobial[21,46], antitumor[47-49], analgesic[50-52], antiplasmodial[53,54], wound healing[45,55,56], insecticidal[57-59], allopathic[60,61], antidiabetic[62], antiviral[63], anticonvulsant[64] and anti-amnesic effects[65]. Previous phytochemical studies have shown that *Conyza* plants are rich in secondary metabolites including terpenoids, phenolic acids, flavonoids and tannins, saponins, terpenoids, glycosides, steroids and alkaloids[66-70]. Their chemical profiles and bioactivities vary with environmental conditions, climatic differences, seasonal variation, postharvest treatment and method of extraction[71]. Some of the compounds have demonstrated potentials as anti-infective agents[21,59].

Chemical composition of essential oils from *Conyza* species have been extensively studied[57,72,73]. Some of the components in the essential oils include limonene, β-farnesene, caryophyllene, spathulenol, β-ocimene, lachnophyllum ester, matricaria ester, germacrene D, α-bergamotene, caryophyllene oxide, pinene, bicyclogermacrene, curcumene, cadinene , sesquiphellandrene, camphene, 2,6,7,7a-tetrahydro-1,5-dimethyl-1H-indene-3-carboxaldehyde, 2-heptylacetate, allo-aromadendrene, bisabolene oxide, carvacrol, cis-sabinol, *epi*-bicyclosesquiphellandrene, humulene, isoeugenol, isospathulenol, mentha-1,3,8-triene, myrcene, neophytadiene, perillaldehyde, phytol, pinocarveol, pulegone, sabinene, terpinolene, zingiberene and β-copaen-4α-ol[19,59].

III. Flavonoids from *Conyza* species

Flavonoids are a group of naturally occurring plant compounds that are widely distributed in fruits, vegetables, herbs and beverages. They are known for their diverse range of biological activities and have been extensively studied for their potential health benefits[74,75]. Numerous positive effects of flavonoids have been shown in an increasing number of research associated to their cardioprotective, anticoagulant antiplatelet, antiviral, antimicrobial, anti-inflammatory, antitumor, anti-allergic, neuroprotective and weight management activity[76,77]. Flavonoids including apigenin (**1**), hispidulin (**2**), luteolin (**3**), conyflavone (**4**), Gardenin C (**5**), takakin 8-*O*-glucuronide (**6**), kampferol (**7**), kaempferol-3-*O*-beta-D-glucopyranoside (**8**), kaempferol 3-*O*-β-rutinoside (**9**), kaempferol 3-*O*-(6"-O-E-caffeoyl)-β-D-galactopyranoside (**10**), quercetin (**11**), rhamanetin (**12**), chrysosplenetin (**13**), 3-*O*-methylquercetin (**14**), 3-O-methylquercetin 7-*O*-β-D-glucopyranoside (**15**), quercetin 3-*O*-β-D-glucopyranoside (**16**), quercetin-3-rutinoside (**17**), 3'-methylquercetin 3-*O*-rutinoside (**18),** isorhamnetin 3-*O*-(6' '-*O*-E-caffeoyl)-β-D-galactopyranoside (**19**), quercetin 3-*O*-(6"-*O*-E-caffeoyl)-β-D-glucopyranoside (**20**), myricetin (**21**), epicatechin (**22**) and conyzoflavone (**23**) have been reported from *Conyza* species (Table 1). Compounds **1, 3** and **6** were isolated from *C. bonariensis* and *C. canadensis*[78,79]. Compound **2** was isolated from *C. bonariensis*[80]; compounds **4, 5** and **13** were isolated from *C. aegyptiaca*[46]; compounds **7**, **11**, **16** and **17** were reported from *C. dioscoridis* and *C. floribunda* [67, 62]; compounds **8**, **9**, **10**, **11**, **18**, **19** and **20** were reported from *C. filaginoides*[81]. Compound **8** was also reported from *C. aegyptiaca*[82] while compounds **11** and **17** were also reported from *C. floribunda* and *C. dioscoridis*[21,62,83]. Compounds **14** and **15** were reported from *C. discoridi*[84] while compounds **21**, **22** and **23** were reported from *C. floribunda*, *C. dioscoridis* and *C. canadensis* respectively[67,61,85].

Table 1: Some flavonoids from *Conyza* species and their bioactivities

Compound	**Species**	**Bioactivity**
Apigenin (**1**)	*C. bonariensis*, *C. canadensis*[78,79]	Antiviral[86,87], antimicrobial[88], anti-inflammatory[89] and cytotoxicity[90]
Hispidulin (4',5,7-trihydroxy-6-methoxyflavone (**2**)	*C. bonariensis*[80]	Allelopathic, antioxidant[93], Analgesic and anti-inflammatory[91,92]
Luteolin (3′,4′,5,7-tetrahydroxyflavone) (**3**)	*C. bonariensis*[78]	Antiviral[94,95] and antimicrobial[88]
Conyflavone (**4**)	*C. aegyptiaca*[46]	Antimicrobial[46,85]
Gardenin C (**5**)	*C. aegyptiaca*[46]	Antimicrobial[46]
Takakin 8-*O*-glucuronide (**6**)	*C. bonariensis*[78]	Antioxidants[78]
Kampferol (**7**)	*C. dioscoridis C. floribunda*[21,62]	Antimicrobial[**21**], antimalarial[**96**], anti-Inflammatory[**97**] and antioxidant[**98**]
Astragalin (**8**)	*C. aegyptiaca*, *C. filaginoides*[82,81]	Antifungal[99] and antiinflamatoty[100]
Nicotiflorin (**9**)	C. *filaginoides*[81]	Hepatoprotective[101], antioxidant[102], anti-inflammatory and antitumor[103]
kaempferol 3-*O*-(6"-*O*-E-caffeoyl)-β-D-galactopyranoside (**10**)	*C. filaginoides*[81]	
Quercetin (**11**)	*C. floribunda*, *C. dioscoridis C. filaginoides*[21,62,81,83]	Antimicrobial[107], cytotoxicity, antioxidant, anti-inflamatory [105,106], antiplasmodial [104]
Rhamanetin (**12**)	*C. dioscoridis* [61]	Herbicidal, antioxidant, anticancer, anti-inflammatory, antiviral and antibacterial[108-110]
Chrysosplenetin (**13**)	*C. aegyptiaca* [46]	Antimicrobial[46], anti-malarial, antiviral, anti-inflammatory[111]
3-O-Methylquercetin (**14**)	*C. discoridis*[84]	
(transilin (**15**)	*C. discoridis* [84]	
Quercetin 3-*O*-β-D-glucopyranoside (Isoquercetin) (**16**)	*C. dioscoridis*[62, 83]	Cytotoxicity, antimicrobial[122], antioxidant, anti-inflammatory, antidiabetic, anti-osteoporotic, antispasmodic, neuroprotective, anti-anxiety[113]
Quercetin-3-rutinoside (rutin) (**17**)	Conyza dioscoridis, C. filaginoides [81,62,83]	Wound healing[112], cytotoxicity, antioxidant, anti-inflammatory, antidiabetic, nephroprotective, anti-osteoporotic, antispasmodic, neuroprotective, anti-anxiety[113]
3'-Methylquercetin 3-O-rutinoside (narcissin) (**18**)	C. Filaginoides, Conyza [81,61]	Antimicrobial[116], hepatoprotective, antioxidant, anti-inflammatory, antinociceptive, antihypertensive and anti-anaphylactic[114,115,117]

Isorhamnetin 3-O-(6"-O-E-caffeoyl)-beta-D-galactopyranoside (**19**)	*C. filaginoides* [81]	
Quercetin 3-O-(6"-O-E-caffeoyl)-beta-D-glucopyranoside (**20**)	*C. filaginoides* [81]	
Myricetin (**21**)	*C. floribunda* [67,21]	Antimicrobial[21], antioxidant [119], anti-inflammatory, antioxidant, anticarcinogenic, neuroprotective effects[118]
Epicatechin (**22**)	*C. dioscoridis* [61]	Antioxidant[120], antimicrobial[12], antiinflamatory[121]
Conyzoflavone (**23**)	*C. canadensis* [85]	Antibacterial and antifunga[85]

Compound **1** exhibited antiviral, antimicrobial, anti-inflammatory and cytotoxicity effects[86-90]. Compound **2** exhibited allelopathic, antioxidant, analgesic and anti-inflammatory activities[91-93]. Compound **3** showed antiviral, anti-inflammatory and antimicrobial activities[88,94,95]. Compounds **4**, **5** and **23** gave antimicrobial activity[46,85] while compound **6** was found to be antioxidant[78]. Compound **7** showed antimicrobial, antimalarial, anti-inflammatory and antioxidant effects[21,96-98]. Compound **8** had antifungal and anti-inflammatory effects[99,100]. Compound **9** had hepatoprotective, antioxidant, anti-inflammatory and antitumor activities[101-103]. Compound **11** gave antimicrobial, cytotoxicity, antioxidant, anti-inflammatory and antiplasmodial activities[104-107]. Compound **12** showed antioxidant, anticancer, anti-inflammatory, antiviral and antimicrobial activities[108-110]. Compound **13** showed antimicrobial, anti-malarial, antiviral and anti-inflammatory activities[46,111]. Compounds **16** and **17** had wound healing, cytotoxicity, antioxidant, anti-inflammatory, antidiabetic, nephroprotective, anti-osteoporotic, antispasmodic, neuroprotective, anti-anxiety effects[112,113]. Compound **18** had antimicrobial, hepatoprotective, antinociceptive, anti-inflammatory, antihypertensive, antioxidant and antianaphylactic effects[114-117]. Compound **21** showed antimicrobial, antioxidant, anti-inflammatory, antioxidant, anti-carcinogenic and neuroprotective activities[21,118,119]. Compound **22** gave antioxidant, antimicrobial and anti-inflammatory effects[12,120,121].

IV. Phenolic Compounds from Conyza Species

Phenolic compounds reported from *Conyza* species (Table 2) include 4-hydroxybenzoic acid (**24**), methyl 4-hydroxybenzoate (**25**), methyl 4-hydroxy-3-methoxybenzoate (**26**), 3,5-dihydroxybenzoic acid (**27**), 3-hydroxy-5-methoxybenzoic acid (**28**), gallic acid (**29**), syringic acid (**30**), caffeic acid (**31**), chlorogenic acid (**32**), 2-(3,4-dihydroxyphenyl) ethyl-2-*O*-[6-deoxy-α-L-mannopyranosyl -4-(3,4-dihydroxyphenyl)-2-propenoate]-β-D-glucopyranoside (**33**), eugenol 4-*O*-glucopyranoside (**34**), 6-hydroxytremetone (**35**), euparin (**36**), 2,4-dihydroxy-6-(β-D-glucopyranosyloxy)phenyl-butan-1-one (**37**), pyromeconic acid (**38**), pyromeconic acid-3-*O*-β-D-glucopyranoside-6′-(*O*-4′′-hydroxybenzoate) (**39**), pyromeconic acid-3-*O*-β-D-glucopyranoside-3′-(*O*-β-D-glucopyranoside)-6′-(*O*-4′′-hydroxybenzoate) (**40**), pyromeconic acid-3-*O*-β-D-glucopyranoside-6′-(*O*-4′′-hydroxy-3′′,5′′-dimethoxybenzoate) (**41**), conyzapyranone A (**42**), conyzapyranone B (**43**) and 5-methylcoumarin-4-*O*-α-D-glucoside (**44**). Compounds **24**, **27**, **39**, **40**, **41** and **43** were reported from *C. canadensis*[79,123,124]. Compounds **25**, **26**, **28**, **30** and **34** were isolated from *C. bonariensis*[78,80]. Compounds **29** and **31**-**33** were isolated from *C. dioscoridis*[62,83,125]. Compounds **31** and **32** were isolated from *C. filaginoides*[62,83,125]. Compounds **35**, **36**, **38** and **44** were reported from *C. triloba*[126] while compound **37** was reported from *C. aegyptiaca* [82].

Compounds **24** exhibited antimicrobial, antioxidant, antimutagenic, antiestrogenic, hypoglycemic, anti-inflammatory, anti-platelet aggregating, antiviral and nematicidal activities[127,128]. Compounds **25** and **26** exhibited allelopathic activities[80]. Compound **29** had cytotoxicity, antimicrobial, anti-inflammatory and antitumor activities[129,130]. Compound **30** exhibited antimicrobial, antioxidant, hepatoprotective, anti-inflammatory, antidiabetic and anticancer effects[101,131-133]. Compound **31** gave antimicrobial, antioxidant, anticancer, antidiabetic, antihypertensive, antimicrobial, hepatoprotective and antiviral effects[134,135]. Compound **32** showed anti-inflammatory, neuroprotective and antioxidant activities[136]. Compound **33** exhibited cytotoxicity effect [83]. Compound **35** exhibited germination inhibition, antimicrobial and antioxidant activities[137]. Compound **36** had antimicrobial and anti-Inflammatory effects[138]. Compound **37** had antioxidant effect[82]. Compounds **42** and **43** exhibited antiproliferative activity[79].

IV. Sesquiterpenoids and diterpenoids from Conyza species

Sesquiterpenoids (Table 3) from Conyza species include vernolepin (**45**), vernomenin (**46**), vernomenin-6-(2-hydroxymethyl)-acrylate (**47**), oplopanone (**48**), opposit-4(15)- ene-1β,7-diol (**49**), dehydrovomifoliol (**50**), roseoside (**51**), inflatenone (**52**), pubescone (**53**), conyterpenol B (**54**), conyterpenol C (**55**), artabotrol (**56**), aphanamol I (**57**), 4 ,7α-aromodendranediol (**58**), macrocarp-11(15)-en-8-ol (**59**), β-caryophyllene-4,5-alpha-oxide (**60**), schisansphenins A (**61**), 10β,15-hydroxy-α-cadinol (**62**), 4(15)-eudesmene-1β,5α-diol (**63**), 1β,6α-dihydroxy-4(15)-eudesmane (**64**), 7-epieudesm-4(15)-ene-1α,6α-diol (**65**), oplodiol (**66**), conyterpenol A (**67**), 1β,11-dihydroxy-5-eudesmene (**68**), 3-epichenopotriol (**69**), 6β,14-epoxyeudesm-4(15)-en-1β-ol (**70**), 15-hydroxy-eudesm-4,11(13)- diene-12-oic acid (**71**), methyl 15-oxo-eudesome-4, 11(13)-diene 12-oate (**72**), 1α,

9α-dihydroxy-α- cyclocostunolide (**73**) and conyterpenol D (**74**). Diterpenoids reported from the plants include labda-8(17),14-diene-3,13-diol (**75**), 13-O-α-L-rhamnopyranosyl labda-8(17),14-dien-3-yl α-L-rhamnopyranoside (**76**), 13-O-α-L-rhamnopyranosyl labda-8(17),14-diene-3-yl 2-O-acetyl-α-L-rhamnopyranoside (**77**), 13-O-α-L-rhamnopyranosylabda-8(17),14-dien-3-yl 6-O-acetyl-β-D-glucopyranosyl-(1→2)-α-L-rhamnopyranoside (**78**), hardwickiic acid (**79**), 2β-hydroxyhardwickiic acid (**80**), conyzolide (**81**), bacchotricuneatin A (**82**), conyclerodane (**83**), centipedic acid (**84**) and tarapacol (**85**). Sesquiterpenoids **45**-**47** and **71** (Table 3) were isolated from *C. discoridis*[84,139]. Compounds **48**-**50**, **52**-**59**, **61**-**70** and **74**-**78** were isolated from *C. japonica*[42,140]. Compounds **51** and **83** were reported from *C. aegyptiaca*[46,82] while compound **60** was isolated from *C. filaginoides*[81]. Compoiunds **71** and **85** were reported from *C. triloba*[126]. Compounds **79**, **80**, **82** and **84** were reported from *C. Coulteri*[141].

Table 2: Some phenolic compounds from *Conyza* Species and their bioactivities

Compound	**Species**	**Bioactivity**
4-Hydroxybenzoic acid (**24**)	*C. canadensis* [123]	Antimicrobial, antioxidant[128], antimicrobial, antialgal, antimutagenic, antiestrogenic, hypoglycemic, anti-inflammatory, anti-platelet aggregating, nematicidal, antiviral, antioxidant[127]
Methyl 4-hydroxybenzoate (**25**)	*C. bonariensis* [80]	Allelopathic [80]
Methyl 4-hydroxy-3-methoxybenzoate (**26**)	*C. bonariensis* [80]	Allelopathic [80]
3,5-Dihydroxybenzoic acid (**27**)	*C. canadensis*[123]	
3-Hydroxy-5-methoxybenzoic acid (**28**)	*C. bonariensis*[78]	
Gallic acid (**29**)	*C. dioscoridis* [83]	Anti-inflammatory, cytotoxic and antitumor[129], Cytotoxicity, antimicrobial [130]
Syringic acid (**30**)	*C. bonariensis* [78]	nAtimicrobial[131], *antidiabetic, antiglycation, hepatoprotective* [132], antioxidant, anti-inflammatory, anticancer [133]
Caffeic acid (**31**)	*C. dioscoridis.C. filaginoides*[62,83,125]	Antimicrobial[135], antioxidant, anticancer, antidiabetic, antihypertensive, antimicrobial, hepatoprotective, antiviral[134]
Chlorogenic acid (**32**)	*C. dioscoridis C. filaginoides*[62,125]	Anti-inflammatory, antioxidant, neuroprotective[136]
2-(3,4-Dihydroxyphenyl)ethyl-2-*O*-[6-deoxy-α-L-mannopyranosyl-4-(3,4-dihydroxyphenyl)-2-propenoate]-β-D-glucopyranoside (**33**)	*C. dioscoridis* [83]	Cytotoxicity [83]
Eugenol 4-*O*-glucopyranoside (**34**)	*C. bonariensis* [78]	
6-Hydroxytremetone (**35**)	*C. triloba* [126]	Germination inhibition, antimicrobial and antioxidant[137]
Euparin (**36**)	*C. triloba* [126]	Antimicrobial and anti-inflammatory [138]
2,4-Dihydroxy-6-(β-D-glucopyranosyloxy)phenyl-butan-1-one (**37**)	*C. aegyptiaca* [82]	Antioxidant [82].
Pyromeconic acid (**38**)	*C. triloba* [126]	
Pyromeconic acid-3-*O*- β-D-glucopyranoside-6′-(*O*-4″-hydroxybenzoate) (**39**)	*C. canadensis* [124]	
Pyromeconic acid-3-*O*-β-D-glucopyranoside-3′-(*O*- β-D-glucopyranoside)-6′- (*O*-4″-hydroxybenzoate) (**40**)	*C. canadensis* [124]	
Pyromeconic acid-3-*O*- β-D-glucopyranoside-6′-(*O*-4″-hydroxy-3″,5″-dimethoxybenzoate) (**41**)	*C. canadensis* [124]	
Conyzapyranone A (**42**)	*C. canadensis* [79]	Antiproliferative[79]
Conyzapyranone B (**43**)	*C. canadensis* [79]	Antiproliferative[79]
5-Methylcoumarin-4-O-α -D-glucoside (**44**)	*C. triloba* [126]	

Compound **45** exhibited cytotoxic, anti-trypanosomal, antimicrobial and platelet anti-aggregating effects[142]. Compound **51** exhibited antioxidant and anti-hypertensive effects[143]. Compounds **55, 61** and **74** showed cytotoxicity and anti-inflammatory activities[42]. Compounds **75**-**78** demonstrated antimicrobial activity[140]. Compound **79** gave leishmanicidal, antinociception and anti-inflammatory effects[144-146]. Compounds **81** and **83** had antimicrobial activity[46,85]. Compounds **82** and **85** showed antioxidant activity[126,147]. Compound **84** had antinociceptive, gastroprotective and antifungal effects[148-150].

V. Triterpenoids and triterpene glycosides from *Conyza* species

Triterpenoids reported from Conyza species (Table 4) include friedelin (**86**), 3α-hydroxyfriedooleanane (**87**), epifriedelanol (**88**), 3-acetoxyfriedooleanane (**89**), 3β-hydroxyolean-12-en-28-oic acid (**90**), B-amyrin (**91**), erythrodiol (**92**), taraxerol (**93**), 3β,16β,20β-trihydroxytaraxast-3-*O*-palmitoxyl ester (**94**), betulinic acid (**95**) and simiarenol (**96**) while triterpene glycosides reported from the plants include conyzasaponins A-Q (**97**-**113**). Compounds **86**, **87**, **89** and **95** were reported from *C. floribunda* [67]. Compounds **86**, **88**, **90**, **92**-**94** and **96** were reported from *C. canadensis*[123,152,79,153]. Triterpene glycosides **97**-**113** were reported from *C. blini*[154,155].

Compound **86** exhibited antimicrobial, antioxidant, anti-inflammatory, analgesic, antitumor and antipyretic effects[156-159]. Compounds **87**, **88, 89** and **94** exhibited antimicrobial activity[152,153,160]. Compound **90** exhibited antimicrobial and anti-inflammatory activities[161,162]. Compound **91** showed antibacterial, anti-fibrotic, antihyperglycemic, hypolipidemic, anti-inflammatory and anti-apoptotic[163,164,165]. Compound **92** showed cytotoxic and anti-inflammatory effects[166]. Compound **93** showed antimicrobial, antidiabetic, anti-inflammatory and anti-cancer activities[157,167,168]. Compound **95** showed antimicrobial, anti-inflammatory, antiviral, antidiabetic, antimalarial, anti-HIV and antitumor[169,170].

Table 3: Some sesquiterpenoids and diterpenoids from *Conyza* species and their bioactivities

Compound	**Species**	**Bioactivity**
Vernolepin (**45**)	*C. discoridis* [84]	Cytotoxic, anti-trypanosomal, antimicrobial, and platelet anti-aggregating[142]
Vernomenin (**46**)	*C. discoridis* [84]	
Vernomenin-6-(2-hydroxymethyl)-acrylate (**47**)	*C. discoridis* [84]	
Oplopanone (**48**)	*C. japonica* [42]	
Opposit-4(15)- ene-1β,7-diol (**49**)	*C. japonica* [42]	
Dehydrovomifoliol (**50**)	*C. japonica* [42]	
Roseoside (**51**)	*C. aegyptiaca*[82]	Antioxidant, anti-hypertensive[143]
Inflatenone (**52**)	*C. japonica* [42]	
Pubescone (**53**)	*C. japonica* [42]	
Conyterpenol B (**54**)	*C. japonica* [42]	
Conyterpenol C (**55**)	*C. japonica* [42]	Cytotoxicity, anti-inflammatory[42]
Artabotrol (**56**)	*C. japonica* [42]	
Aphanamol I (**57**)	*C. japonica* [42]	
4α,7α-Aromodendranediol (**58**)	*C. japonica*[42]	
Macrocarp-11(15)-en-8-ol (**59**)	*C. japonica* [42]	
β-Caryophyllene-4,5-alpha-oxide (**60**)	*C. filaginoides* [81]	
Schisansphenin A (**61**)	*C. japonica* [42]	Cytotoxicity, anti-inflammatory[42]
10β,15-Hydroxy-α-cadinol (**62**)	*C. japonica* [42]	
4(15)-Eudesmene-1β,5α-diol (**63**)	*C. japonica* [42]	
1β,6α-Dihydroxy-4(15)-eudesmane (**64**)	*C. japonica* [42]	
7-Epieudesm-4(15)-ene-1α,6α-diol (**65**)	*C. japonica* [42]	
Oplodiol (**66**)	*C. japonica* [42]	
Conyterpenol A (**67**)	*C. japonica* [42]	
1β,11-Dihydroxy-5-eudesmene (**67**)	*C. japonica* [42]	
3-Epichenopotriol (**69**)	*C. japonica* [42]	
6β,14-Epoxyeudesm-4(15)-en-1β-ol (**70**)	*C. japonica* [42]	
15-Hydroxy-eudesm-4,11(13)- diene-12-oic acid (**71**)	*C. triloba*, *C. discoridis*[126,139]	
Methyl 15-oxo-eudesome-4, 11(13)-diene 12-oate (**72**)	*C. dioscoridis*[61]	
1α, 9α-Dihydroxy-α- cyclocostunolide (**73**)	*C. dioscoridis*[61]	
Conyterpenol D (**74**)	C. *japonica*[42]	Cytotoxicity, anti-inflammatory [42]
(13S)-Labda-8(17),14-diene-3,13-diol (**75**)	*C. japonica*[140]	Antimicrobial[140]
(3β,13S)-13-O-α-L-Rhamnopyranosyllabda-8(17),14-dien-3-yl α-L-rhamnopyranoside (**76**)	*C. japonica*[140]	Antimicrobial[140]
(3β,13S)-13-O-α-L-Rhamnopyranosyllabda-8(17),14-diene-3-yl 2-O-acetyl-α-L-rhamnopyranoside (**77**)	*C. japonica*[140]	Antimicrobial[140]
(3β,13S)-13-O-α-L-Rhamnopyranosylabda-8(17),14-dien-3-yl 6-O-acetyl-β-D-glucopyranosyl-(1→2)-α-L-rhamnopyranoside (**78**)	*C. japonica*[140]	Antimicrobial[140]
Hardwickiic acid (**79**)	*C. Coulteri*[141]	Leishmanicidal[144] , antinociception[145], anti-inflammatory[146]
2β-Hydroxyhardwickiic acid (**80**)	*C. Coulteri*[141]	
Conyzolide (**81**)	*C. canadensis*[85]	Antibacterial, antifungal[85]
Bacchotricuneatin A (**82**)	*C. Coulteri*[141]	Antioxidant[147], antifeedant, insecticidal[151]
Conyclerodane (**83**)	*C. aegyptiaca*[46]	Antimicrobial[46]
Centipedic acid (**85**)	*C. Coulteri* [141]	Antinociceptive [148], antifungal [149], gastroprotective [150]
Tarapacol (**85**)	*C. triloba*[126]	Antioxidant [126]

VI. Steroids and steroid glycosides from *Conyza* species

Steroid and steroid glycosides (Table 5) from *Conyza* species include stigmasterol (**114**), stigmasterol acetate (**115**), stigmasterol-3-*O*-β-D-glucopyranoside (**116**), *β*-sitosterol (**117**), daucosterol (**118**), (24S)-ethylcholesta-5,25-dien-3-*O*-β-glucoside (**119**), (24S)-ethylcholesta-5,22E,25-trien-3-*O*-glucosyl (1"→4')-rhamnoside (**120**), spinasta 7, 22-dien-3-ol (**121**), conyzagenin A (**122**), conyzagenin B (**123**) and cyasterone (**124**).Compounds **114**, **117** and **118** were reported from *C. aegyptiaca*[67,78,79,83]. Compounds **114**, **115**, **119-121**

and **124** were reported from *C. floribunda* [66,67]. Compound **116** was reported from C. sumatrensis [49]. Compound **114**, **117**, **118**, and **121-123** were reported from C. canadensis[79,153,46].

Compound **114** exhibited antimicrobial, antidiabetic, anticancer, hepatoprotective, antioxidant, acaricidal and insecticidal activities[171]. Compounds **115, 119, 120** exhibited antimicrobial activity[21]. Compound **116** showed cytotoxic effect[49]. Compound **117** exhibited lipid lowering, immunomodulatory, anti-cancer, antimicrobial, hepatoprotective, wound healing, antidiabetic, antioxidant, anti-inflammatory and analgesic effects[172-179]. Compound **118** showed antimicrobial, cytotoxicity, neuroprotective, antioxidant, anti-inflammatory, antidiabetic and immunomodulatory effects[180,181]. Compound **121** showed antidiabetic, anti-inflammatory, antioxidant, neuroprotective, anticonvulsive, antiulcer, hypolipidemic, antitumor and antimicrobial[182]. Compound **124** showed antimicrobial and anticancer activities[183].

Table 4: Some triterpenoids and their glycosides from *Conyza* species and their bioactivities

Compound	**Species**	**Bioactivity**
Friedelin (**86**)	*C. floribunda*, *C. canadensis* [67,79]	Antimicrobial[67,157], anti-inflammatory, analgesic and antipyretic[156], antioxidant [158], antitumor [159]
3α-Hydroxyfriedooleanane (**87**)	*C. floribunda* [67]	Antimicrobial [67]
Epifriedelanol (**88**)	C. canadensis[79]	Antibacterial[160]
3-Acetoxyfriedooleanane (**89**)	*C. floribunda* [67]	Antimicrobial[21]
3β-Hydroxyolean-12-en-28-oic acid (**90**)	*C. canadensis*[123]	Anti-inflammatory [161], antimicrobial[162]
B-Amyrin (**91**)	*C. bonariensis*[78]	Antihyperglycemic, hypolipidemic [163], antibacterial [164], anti-fibrotic, anti-inflammatory, anti-apoptotic [165]
Erythrodiol (**92**)	*C. filaginoides*, *C. canadensis* [81,123.]	Cytotoxic, anti-inflammatory [166]
Taraxerol (**93**)	*C. canadensis* [79]	Antimicrobial [157], anti-diabetic anti-inflammatory[167], anti-cancer [168]
3β,16β,20β-Trihydroxytaraxast-3-*O*-palmitoxyl ester (**94**)	*C. canadensis* [152,153]	Antimicrobial
Betulinic acid (**95**)	*C. floribunda* [67]	Antimicrobial[170], anti-inflammatory, , antiviral, antidiabetic, antimalarial, anti-HIV and antitumor [169]
Simiarenol (**96**)	*C. canadensis*[79]	
Conyzasaponin A (**97**)	*C. blini* [154]	
Conyzasaponin B (**98**)	*C. blini* [154]	
Conyzasaponin C (**99**)	*C. blini* [154]	
Conyzasaponin D (**100**)	*C. blini* [155]	
Conyzasaponin E (**101**)	*C. blini* [155]	
Conyzasaponin F (**102**)	*C. blini* [155]	
Conyzasaponin G (**103**)	*C. blini* [154]	
Conyzasaponin H (**104**)	*C. blini* [155]	
Conyzasaponin I (**105**)	*C. blini* [155]	
Conyzasaponin J (**106**)	*C. blini* [155]	
Conyzasaponin K (**107**)	*C. blini* [155]	
Conyzasaponin L (**108**)	*C. blini* [155]	
Conyzasaponin M (**109**)	*C. blini* [155]	
Conyzasaponin N (**110**)	*C. blini* [155]	
Conyzasaponin O (**111**)	*C. blini* [155]	
Conyzasaponin P (**112**)	*C. blini* [155]	
Conyzasaponin Q (**113**)	*C. blini* [155]	

VII. Other compounds from Conyza species

Enyne derivatives including 4Z)-Lachnophyllum ethyl ester (**125**), (4Z)-lachnophyllum lactone (**126**), (2Z,8Z)-matricaria acid methyl ester (**127**), 8,9-dihydroxymatricarine methyl ester (**128**), 4Z,8Z)-matricaria lactone (**129**) and 4E,8Z-matricaria-γ-lactone (**130**) have been reported from Conyza species (Table 6). Sphingolipids 1,3,5-trihydroxy-2-hexadecanoylamino-(6*E*,9*E*)-heptacosdiene (**131**), 1,3,5-trihydroxy-2-hexadecanoylamino-(6*E*,9*E*)-heptacosdiene-1-*O*-glucopyranoside (**132**), 1,3-dihydroxy-2-hexanoylamino-(4*E*)-heptadecene (**133**) and bonaroside (**134**) were also reported. Other componds include 9,12,13-trihydroxy-10(E)-octadecenoic acid (**135**), 2,3-dihydroxylpropyl hexacosanoate (**136**), *n*-triacontanol (**137**) and an alkaloid 4-hydroxypyridin-3-carboxylic acid 4-*O*-glucopyranoside (**138**).

Compounds **125-127**, **129**, **130**, **134** and **138** were reported from *C. bonariensis*[59,78,79, 80,184]. Compounds **126-133** and **135** were reported from *C. canadensis.* Compound **125** gave allelopathic, antimicrobial and antioxidant activities [80,185]. Compounds **126-130** showed allelopathic, antimicrobial, cytotoxic effects [80,152,186].

Compound **134** showed antioxidant effect[187]. Compound **136** showed cytotoxic activity [49] while compound **137** had plant growth stimulant effect[188].

Table 5: Some steroids and steroid glycosides from *Conyza* species and their bioactivities

Compound	**Species**	**Bioactivity**
Stigmasterol (**114**)	*C. aegyptiaca, C. floribunda*, C. canadensis[46,66,79]	Antimicrobial, antidiabetic, anticancer, hepatoprotective, antioxidant, acaricidal, insecticidal [171]
Stigmasterol-acetate (**115**)	*C. floribunda* [67]	Antimicrobial [67]
Stigmasterol-3-*O*-β-D-glucopyranoside (**116**)	*C. sumatrensis* [49]	Cytotoxic [49]
β-sitosterol (**117**)	*C. aegyptiaca*, C. canadensis, C. bonariensis [46,78,79]	Anti-inflammatory, analgesic [172], antimicrobial [179], lipid lowering, immunomodulatory, anti-cancer, hepatoprotective, wound healing, antidiabetic, antioxidant[173-178]
Daucosterol (**118**)	*C. aegyptiaca , C. blini, C. bonariensis, C. dioscoridis*[46,78,83]	Antimicrobial, cytotoxicity, neuroprotective, antioxidant, anti-inflammatory, antidiabetic, immunomodulatory [180,181]
(24S)-Ethylcholesta-5,25-dien-3-*O*-β-glucoside (**119**)	*C. floribunda* [67]	Antimicrobial [67]
(24S)-Ethylcholesta-5, 22E, 25-trien-3-*O*-glucosyl (1"→ 4')-rhamnoside (**120**)	*C. floribunda* [67]	Antimicrobial [67]
Spinasta 7, 22-dien-3-ol (**121**)	*C. canadensis, C. floribunda* [67,79]	Anti-diabetic, anti-inflammatory, antioxidant, neuroprotective, anti-convulsive, antiulcer, hypolipidemic, antitumor and antimicrobial[182]
Conyzagenin A (**122**)	C. canadensis [153]	
Conyzagenin B (**123**)	C. canadensis [153]	
Cyasterone (**124**)	*C. floribunda* [67]	Antimicrobial, anti-cancer [26,183]

Table 6: Enyne derivatives, sphingolipids and other compounds and their bioactivities

Compound	**Species**	**Bioactivity**
(4Z)-Lachnophyllum ethyl ester (**125**)	*C. bonariensis* [80,59]	Allelochemicals, antimicrobial, antioxidant [80] [185]
(4Z)-lachnophyllum lactone (**126**)	*C. bonariensis, C. canadensis*[59,80184,186]	Allelopathetic, antimicrobial, cytotoxic) [80,186]
(2Z,8Z)-matricaria acid methyl ester (**127**)	*C. bonariensis, C. canadensis* [59,184,186]	Allelopathetic, antimicrobial [186]
8,9-dihydroxymatricarine methyl ester (**128**)	*C. canadensis* [152]	Antimicrobial [152]
(4Z,8Z)-matricaria lactone (**129**)	*C. bonariensis, C. canadensis* [79,184,80,186]	Allelopathetic, antimicrobial [80,186]
4E,8Z-matricaria lactone (**130**)	*C. bonariensis , C. canadensis* [79,80]	Allelochemicals [80]
1,3,5-trihydroxy-2-hexadecanoylamino-(6*E*,9*E*)-heptacosdiene (**131**)	*C. canadensis* [123]	
1,3,5-trihydroxy-2- hexadecanoylamino-(6*E*,9*E*)-heptacosdiene-1-*O*-glucopyranoside (**132**)	*C. canadensis* [123]	
1,3-dihydroxy-2-hexanoylamino-(4*E*)-heptadecene (**133**)	*C. canadensis* [123]	
Bonaroside (**134**)	*C. bonariensis* [78]	Antioxidant [187]
9,12,13-trihydroxy-10(E)- octadecenoic acid (**135**)	*C. canadensis* [79]	
2,3-dihydroxylpropyl hexacosanoate (**136**)	*C. sumatrensis* [49]	Cytotoxic [49]
n-triacontanol (**137**)	*C. blini* [189]	Plant growth stimulant [188]
4-hydroxypyridin-3-carboxylic acid 4-O-glucopyranoside (**138**)	*C. bonariensis* [78]	

VIII. Conclusion

The findings from this study confirm that Conyza species have a wide range of bioactivities and therefore can be used cure many kinds of illnesses. The biological activities can be attributed to the presence of the chemical compounds in the plants. Previous phytochemical test have shown that *Conyza* species are rich in alkaloids. However, the information about the alkaloids previously isolated from *Conyza* species is scanty. Further studies should be done isolate and characterize the alkaloids from the plants.

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