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Research Article

Fatty Acid Composition and Antimicrobial Activity of *Solanum torvum* SW.

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Abstract

The genus *Solanum* plants have different uses; some are used as foods, and some species as remedy in traditional medicine. The chloroform-methanol (2:1, v/v) extracts of stem, leaf, pericarp and root of *Solanum torvum*, which were collected from Medicinal Plant Garden, Ragavendra Medical Institute of Electropathy, Erode, Tamil Nadu, India were obtained by Soxhlet apparatus. The fatty acids obtained from plant extracts were esterified and subjected to detailed GC-MS analysis. The plant extracts from the stem, leaf, pericarp and root contained unsaturated fatty acids such as linoleic acid, and oleic acid, and a saturated fatty acid like palmitic acid, stearic acid, richinoleic acid, ligniceric acid, lauric acid, myristic acid and behanic acid. The antimicrobial activities of the ethanolic extracts of those samples were determined against ten bacteria and nine fungi. Among the tested bacterial strains, *Bacillus* sp, *Klebsiella pneumoniae*, *Staphylococcus aureus* and *Micrococcus* sp showed maximum antibacterial activity to all the tested extracts of *Solanum torvum*. The higher antifungal activity of plant extracts were found against *Trichophytonton surans* and *Aspergillus niger*.

Keywords: *Solanum torvum*, fatty acid composition, antimicrobial activity, GC-MS analysis

INTRODUCTION

In recent years, multiple resistances in human pathogenic microorganisms have developed due to the indiscriminate use of commercial antimicrobial drugs commonly employed in the treatment of infectious diseases. This situation, the undesirable side effects of certain antibiotics and the emergence of previously uncommon infections (Poole, 2001) have forced scientists into looking for new antimicrobial substances from various sources like medicinal plants. The screening of plant extracts and plant products for antimicrobial activity has shown that higher plants represent a potential source of new anti-infective agents (Salvat *et al*., 2001).

Solanum torvum Sw. belonging to family Solanaceae is a bushy, erect and spiny perennial plant used horticulturally as a rootstock for eggplant. Different parts of the plants are used as sedative, diuretic and digestive. They are also used in the treatment of coughs and colds (Yuanyuan *et al*., 2009). Leaves are used as haemostatic. Extract of the fruits and leaves are said to be useful in case of liver and spleen enlargement and in the treatment of cough. Paste of root is used to cure cracks in feet. The fume of burning seeds is inhaled for toothache (Bhakuni *et al*., 1962 & 1969). Leaves and Fruits have been reported to contain the steroidal gluco-alkaloid, solasonine, steroidal sapogenins, neochlorogenin, neosolaspigein, solaspigenine, triacontanol, tetratriacontanic acid, z-tritriacontanone, sitosterol, stigmasterol, campesterol, protein, fat and minerals (Yuanyuan *et al*., 2009).

Fatty acids are widely occurring in natural fats and dietary oils and they play an important role as nutritious substances and metabolites in living organisms (Cakir, 2004). Many fatty acids are known to have antibacterial and antifungal properties (Russel, 1991). However, little is known on the antibacterial and antifungal properties of *S. torvum*. Hence, the present study was planned to identify the fatty acid profile from different parts like ethanolic extracts of stem, leaves, pericarp and root of *S. torvum* and their antimicrobial properties.

MATERIALS AND METHODS

Collection and preparation of plant sample

Naturally grown plants of *S. torvum* were collected from the medicinal plant garden of Ragavendra Medical Institute of Electropathy, Erode. The whole plants were washed with tap water and shade dried. Then the plants were separated into stem, leaf, pericarp and root. All the separated parts were subjected in to shade drying for 10-15 days. Then the dried

parts were ground into powder. Then dried powder of the each samples were taken for fatty acid activity.

Fatty acid analysis

Extraction

Ten grams of the samples like stem, leaf, pericarp and root are homogenized and successively extracted three times with chloroform–methanol (2:1, v/v) to isolate the lipids. The chloroform phase is separated from the combined extract, dried over anhydrous sodium sulphate and concentrated under a nitrogen atmosphere.

The lipophilic extract (100 mg) was dissolved in 4 ml of 5 % hydrochloric acid in methanol and 0.5 ml benzene and then the mixture was refluxed in a water bath at 80–100°C for 2 h. Then a drop of methyl orange indicator and acidify with 20% methanolic H_2SO_4 added and thoroughly vortexes for 1 min. Then this mixture extracted with petroleum ether (40–60) and collects the ether layer through sodium sulphate in to the buffer. One ml aliquot is injected into gas chromatography.

GC-MS analysis of plant sample

A Chemito (GC 8610) gas chromatograph is performed with BPX-wax fused silica capillary column (30m × 0.22mm i.d., 0.25 mm film thickness). The injector and flame ionization detector are 250°C and 260°C. The column temperature program is started from 160°C hold for 1 min, then rise to 240°C with the heating rate of 6°C/min hold for 3 min and final temperature increase to 240°C with at a rate of 6°C/min and hold 5 min. The pressure of nitrogen carrier gas is 100 kPa at a flow rate of 30 ml/min.

Antimicrobial activity

Sample preparation

Twenty grams of dried powder of stem, leaves, pericarp and roots were loaded on soxhlet apparatus, ethanol: water (4:1) used as solvent at 42°C for 4 hrs. After extraction ethanol were evaporated by vacuum filter. The stem, leaves, pericarp and root extracts were taken for antimicrobial study.

Antimicrobial activity

The *in vitro* antibacterial and antifungal activities of the extracts were evaluated by the well diffusion method (DDM) using Mueller Hinton agar for bacteria and Sabouraud dextrose agar for fungi (Baron and Finegold, 1990). Well containing 50 µl of the ethanolic extracts was used and growth inhibition zones were measured after 24 h and 48 h of incubation at 37 and 24°C for bacteria and fungi, respectively. The pathogenic bacteria used were: *Escherichia coli*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Micrococcus sp*, *Enterococcus faecalis*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Klebsiella pneumoniae*, *Streptococcus* sp. and *Bacillus* sp. The pathogenic fungi used were: *Aspergillus niger*, *A. flavus*, *A. fumigatus*, *A. oryzae*, *Candida albicans*, *Epidermophyton floccosum*, *Madura mycetoma*, *Trichophyton mentagrophyte*, *T. rubrum* and *T. tonsurans*.

RESULTS AND DISCUSSION

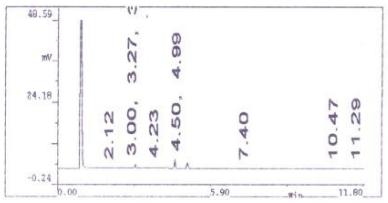
Fatty acid analysis

The analysis of fatty acid extracts of *S. torvum* by gas chromatography revealed higher amount of unsaturated fatty acids than saturated fatty acids. The main compounds are identified as unsaturated fatty acids such as linoleic acid, and oleic acid, and a saturated fatty acid, palmitic acid, stearic acid, richinoleic acid, ligniceric acid, Lauric acid, myristic acid and behanic acid (Figures 1–4).

In the present study, root and stem extracts of *S. torvum* had a higher proportion of unsaturated fatty acids compared to pericarp and leaf extracts. Oleic acid and linoleic acid was detected in a high amount in root (38.72% and 43.03% respectively) and stem (40.05% and 30.53%) as an ester derivatives obtained from extract of this plant. Some hydrocarbon compounds were found in leaf (6.1%) and seed (5.1%). Similar studies are also found by authors Cotrufo and Lunsetter, 1963 (*Solanum tuberosum*), Dhellot *et al*., 2006 (*S. nigrum*) and Bansal *et al*., 2009 (*S. xanthocarpum*).

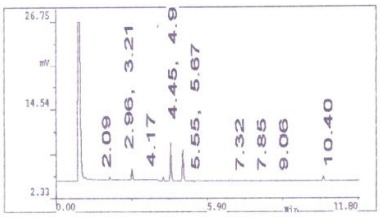
Antimicrobial activity

The data pertaining to the antibacterial potential of the plants extracts of *S. torvum* are presented in Table 1. The results show that ethanolic extract of *S. torvum* has antibacterial activity against all 10 investigated bacteria. All extracts of *S. torvum* registered inhibitory activity for both gram-negative and gram-positive bacteria. The diameter inhibition zones ranged from 7 mm to 19.3 mm (not including the diameter of the well) with the high zone values observed in root extract against *Bacillus* sp (19.3 mm), pericarp extract against *K. pneumonia* (17.0 mm) and stem extract against *Bacillus* sp (16.9 mm). The low one values registered in pericarp extract against *P. aeruginosa* and *S. epidermidis* (7.0 mm). This variation in the effectiveness of the different extracts against different microorganisms depends upon the chemical composition of the extracts and membrane permeability of the microbes' forthe chemicals and their metabolism. It has been suggested that the antimicrobial activity is mainly due to the presence of essential oils, flavanoids and terpenoids and other natural polyphenoilc compounds or free hydroxyl groups (Rojas *et al*., 2003).



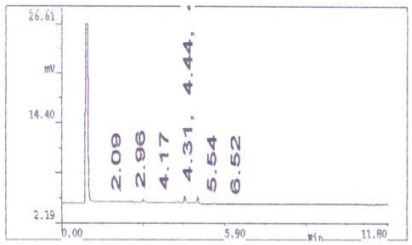
Sr.No	R.T.	Area	Area %	Compd Name
1	1.16	5027	1.6390	
2	1.55	682	0.2224	Lauric
3	2.12	4799	1.5647	Myristic
4	3.00	45843	14.9470	Palmitic
5	3.27	686	0.2237	Palmitolic
6	3.33	283	0.0923	
7	4.23	23930	7.8023	Stearic
8	4.50	122863	40.0593	Oleic
9	4.99	93649	30.5341	Linoleic
10	7.40	528	0.1722	Behanic
11	10.47	7775	2.5350	Richinoleic
12	11.29	638	0.2080	
		306703		

Figure 1: GC-MS Chromatogram of stem extract of *S. torvum*



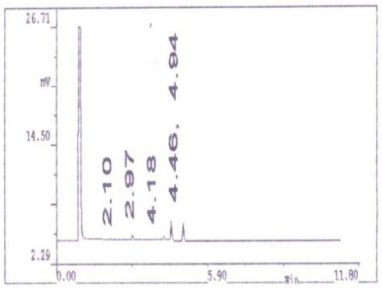
Sr.No	R.T.	Area	Area %	Compd Name
1	1.54	6555	0.9306	Lauric
2	2.09	13965	1.9826	Myristic
3	2.96	94109	13.3604	Palmitic
4	3.21	1278	0.1814	Palmitolic
5	4.17	29577	4.1990	Stearic
6	4.45	233574	33.1599	Oleic
7	4.94	270640	38.4220	Linoleic
8	5.55	12056	1.7115	
9	5.67	3678	0.5222	Linolenic
10	7.32	5229	0.7423	Behanic
11	7.85	1359	0.1929	
12	9.06	1336	0.1897	Lignoceric
13	10.40	31032	4.4055	
		704388		

Figure 3: GC-MS Chromatogram of pericarp extract of *S. torvum*



Sr.No	R.T.	Area	Area %	Compd Name
1	1.16	1998	1.8221	
2	2.09	798	0.7277	Myristic
3	2.96	15687	14.3058	Palmitic
4	4.17	7834	7.1442	
5	4.31	1173	1.0700	Stearic
6	4.44	45700	41.6759	
7	4.92	32757	29.8728	Linoleic
8	5.54	3708	3.3815	
		109655		

Figure 2: GC-MS Chromatogram of leaf extract of *S. torvum*



Sr.No	R.T.	Area	Area %	Compd Name
1	1.16	3967	1.6967	
2	2.10	2414	1.0325	Myristic
3	2.97	26404	11.2934	Palmitic
4	4.18	9873	4.2228	Stearic
5	4.46	90531	38.7214	Oleic
6	4.94	100612	43.0332	Linoleic
		233801		

Figure 4: GC-MS Chromatogram of root extract of *S. torvum*

The data pertaining to the antifungal potential of the pericarp and root extracts of *S. torvum* are presented in Table 2. The results show that ethanolic extract of *S. torvum* has antibacterial activity against all 10 investigated fungi. All extracts of *S. torvum* registered inhibitory activity for all fungi tested. The higher antifungal activity (58% and 55% inhibition) of pericap extract was found against *T. tonsurans* and *Aspergillus niger* while the lower activity (15% inhibition) of root extract was found against *A. oryzae*. The mechanism of action of the ethanolic extracts of *S. torvum* against the pathogenic fungal isolates may be due to inhibition of fungal cell wall due to pore formation in the cell and leakage of cytoplasmic constituents by the active components such as alkaloids, flavonoid), protein, amino acid and sphingohpid biosynthesis and electron transport chain (Shelton, 1991; Lartey and Moehle, 1997; Ueki and Taniguchi, 1997; Dominguez and Martin, 1998).

Table 1: Antibacterial activities of *S. torvum*

Name of bacteria	Leaf extract	Stem extract	Pericap extract	Root extract
Bacillus sp	13.2 ± 0.5^{a}	16.9 ± 0.68	19.3 ± 0.38^{ab}	15.2 ± 0.3^{a}
E. coli	-	-	-	-
Micrococcus sp	13.2 ± 0.72^{a}	14 ± 0.32^{a}	12 ± 0.85^{ab}	15.2 ± 0.62
E. faecalis	-	-	-	-
K. pneumoniae	13 ± 0.4	15.8 ± 0.32^{b}	16.2 ± 0.83^{ac}	17 ± 0.32^{b}
P. mirabilis	-	-	-	-
P. aeruginosa	10 ± 0.8^{b}	-	7 ± 0.83^{bc}	-
S. epidermidis	14 ± 0.32	6.5 ± 0.008	15 ± 0.36	7 ± 0.31^{b}
S. aureus	13.5 ± 0.82^{b}	12 ± 0.81^{a}	10 ± 0.36^{c}	14 ± 0.82
Streptococcus sp.	12 ± 0.32	13 ± 0.0012	7 ± 0.32	8 ± 0.06

Table 2: Antifungal activity of *S. torvum*

Name of the fungi	Root extract	pericarp extract
A. flavus	15.8 ± 0.28^{c}	35.4 ± 0.82^{ef}
A. fumigatus	9.8 ± 0.36	35.5 ± 0.64
A. niger	46.98 ± 0.30	55.0 ± 0.5
A. oryzae	15.80 ± 3.6	41.2 ± 1.5^{ef}
E. floccosum	17.18 ± 3.2^{b}	31.9 ± 0.42
M. mycetoma	26.1 ± 0.08	29.78 ± 0.40
T. mentagrophyte	12.8 ± 0.001	42.8 ± 0.32^{f}
T. rubrum	16.81 ± 0.08	49.72 ± 0.68
T. tonsurans	17.62 ± 0.32	58.62 ± 0.35

REFERENCES

Bansal SK, Singh KV and Kumar S. 2009. Larvicidal activity of the extracts from different parts of the plant *Solanum xanthocarpum* against important mosquito vectors in the arid region. *Journal of Environmental Biology* 30:221–226.

Baron EJ and Finegold SM. 1990. Bailey and Scott's Diagnostic Microbiology. 8th Edn., CV Mosby Co., St. Louis, USA., pp 286–402; 435–438.

Bhakuni DS, Dhar ML, Dhar MM, Dhawan BN and Mehrotra BN. 1969. Screening of Indian plants for biological activity: Part II. *Indian Journal of Experimental Biology* 7:250–262.

Bhakuni DS, Srivastava SN, Sharma VN and Kaul KN. 1962. Chemical examination of the fruits of *Coccinia indica* W. and A. *Journal of Science and Industrial Research* 21B:237–238.

Cakir A. 2004. Essential oil and fatty acid composition of the fruits of *Hippophae rhamnoides* L. (Sea Buckthorn) and *Myrtus communis* L. from Turkey. *Biochemical Systematics and Ecology* 32:809–816.

Cotrufo C and Lunsetter P. 1964. The fatty acids of *potato* tubers *(Solanum tuberosum). American Journal of Potato* Research 41:18–22.

Dhellot JR, Matouba E, Maloumbi MG, Nzikou JM, Dzondo MG, Linder M, Parmentier M and Desobry S. 2006. Extraction and nutritional properties of *Solanum nigrum* L seed oil. *African Journal of Biotechnology* 5:987–991.

Dominguez, JM and Martin JJ. 1998. Identification of elongation factor 2 as the essential protein targeted by sordarins in *Candida albicans*. *Antimicrobial Agents Chemotherapy* 42:2279–2283.

Lartey PA and Moehle CM. 1997. Recent advances in antifungal agents. In: Annual Reports in Medicinal Chemistry, Plattner, JJ (Ed.). Academic Press, London, pp 151–160.

Poole K. 2001. Overcoming antimicrobial resistance by targeting resistance mechanisms. *Journal of Pharmacy Pharmacology* 53:283–284.

Rojas R, Bustamante B, Bauer J, Fernandez I, Alban J and Lock O. 2003. Antimicrobial activity of selected Peruvian medicinal plants. *Journal of Ethnopharmacology* 88:199–204.

Russel AD. 1991. Mechanisms of bacterial resistance to non-antibiotics: food additives and food pharmaceutical preservatives. *Journal of Applied Bacteriology* 71:191–201.

Salvat A, Antonnacci L, Fortunato RH, Suarez EY and Godoy HM. 2001. Screening of some plants from Northern Argentina for their antimicrobial activity, *Letters in Applied Microbiology* 32:293–297.

Shelton RM. 1991. *Aloe vera*: Its chemical and therapeutic properties. *International Journal of Dermatology* 30:679–683.

Ueki M and Taniguchi M, 1997. The mode of action of UK 2A and UK 3A novel antifungal antibiotics from *Streptomyces* sp. *Journal of Antibiotics* 50:1052–1057.

Yuanyuan LU, Jianguang L, Xuefeng H and Lingyi K. 2009. Four steroidal glycosides from *Solanum torvum* and their cytotoxic activities. *Steroids* 74:95–101.