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Chemical Composition of the Hexane Extract from the Leaves of *Solanum pseudocapsicum*

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Abstract: The chemical compositions of hexane extractable fractions of the leaves of *Solanum pseudocapsicum* were analyzed by GC-MS. Out of the 35 compounds detected, 26 were identified. The first fraction was dominated by aliphatic hydrocarbons with decane (44.1%), undecane (24.6%) and nonane (6.1%) as the main constituents, while the second fraction was dominated by decane (24.9%), undecane (13%), tetradecane (10.0%) and hexadecane (8.3%). The main constituents of the third fraction were nonane (20.7%), α -terpinolene (7.2%). The acyclic diterpene phytol (35.8%), fatty acids (32.5%) and α -terpinolene (6.3%) dominated the fourth fraction. Other notable components identified include ketones and esters. The high percentage of hydrocarbons, terpenes and fatty acids could contribute to the understanding of the biological characteristics of this species as a poisonous plant.

Key words: *Solanum pseudocapsicum*, solanaceae, GC-MS, chemical composition, hydrocarbons, terpenes, organic acids, non-polar fractions

INTRODUCTION

Solanum pseudocapsicum L. (Solanaceae), known as winter cherry, is a poisonous plant. It is a cosmopolitan erect and highly branched shrub with non-spiny stems reaching a height of 0.6-1.2 m. It bears small star-shaped flowers with dark-green lanceolate leaves. At maturity, its glabrous red to yellow berries are attractive, hence its cultivation as an indoor ornamental.

Although poisonous, the plant is used for the treatment of acute abdominal pain (Boericke, 1997) boils, gonorrhoea and as tonic for men (Batten and Bokelmann, 1966). The hepatoprotective, cytotoxic and antioxidant properties of extracts from the leaves of this plant have been reported (Vijayan *et al.*, 2003, 2004; Badami *et al.*, 2005). Phytochemical studies have revealed the presence of solanocapsine and other alkaloids that are reported to be fatal to man and animals (Der Marderosian *et al.*, 1976; Chakravarty *et al.*, 1984). There is little or no information available in the literature on the non-polar constituents of this species.

As part of an ongoing study on the documentation of the biological characteristics of this species, hexane extract was fractionated and analyzed by gas chromatography-mass spectrometry. In this study, we report the chemical composition of the hexane fractions from the leaves of *S. pseudocapsicum*.

MATERIALS AND METHODS

Plant material: The leaves of *S. pseudocapsicum* was collected from a natural population on the campus of the University of Fort Hare in Alice, South Africa. The plant was authenticated in the Department of Botany and a voucher specimen was prepared and deposited in the Griffen Herbarium of the University of Fort Hare.

Extraction and fractionation: Two hundred grams of the air-dried leaves were pulverized and extracted three times in hexane for a total of 24 h. The extract was filtered and concentrated to dryness under reduced pressure at 40°C to yield 800 mg of extract. The extract (800 mg) was adsorbed in silica gel and later packed into a column of silica gel (0.063-0.200 mm) using vacuum liquid chromatography. The column was eluted with hexane as the mobile phase to yield F1-F3 and thereafter washing with ethyl acetate to give the fourth fraction (F4). After solvent evaporation, the fractions were re-suspended in hexane before the analysis.

GC-MS analysis of the compounds: GC-MS analysis of the volatile components was performed on a Hewlett-Packard HP5973 mass spectrometer interfaced with an HP-6890 gas chromatograph. The following column and temperature conditions were used: Initial temp 70°C, maximum temp 325°C, equilibrium time 1.00 min, ramp

5.0°C min⁻¹ and final temperature 240°C; inlet: splitless, initial temperature 220°C, pressure 8.27 psi, purge flow 30 mL min⁻¹, purge time 0.20 min, gas type helium; column: capillary, model number HP 19091M-433, HP-5 trace analysis 5% phenyl methyl, length 30.0 m, nominal diameter 250.0 µm, film thickness 0.25 µm, initial flow 0.7 mL min⁻¹, initial pressure 8.27 psi, average velocity 32 cm sec⁻¹, front inlet, outlet MSD; MS: EI method at 70 eV. Peaks were analyzed using the Hewlett-Packard Enhanced Chem Station G1701 BA version b.01.00 programme for Windows. For retention index determinations, n-Alkanes were run under the same conditions.

Identification of the constituents: Constituents of the volatiles were identified by comparison of their Mass Fragmentation (MS) pattern and GC retention times (retention indices) with those of authentic compounds, published references and spectra recorded in the Wiley 275 (Wiley New York) mass spectral library and associated data base (Adams, 1989; Joulain and Koenig, 1998).

RESULTS AND DISCUSSION

The components identified from the extract fractions and their percentage compositions are summarized in Table 1. Twenty-six compounds were identified which accounted for 40-81% of the composition. The area of the GC/MS peaks depends not only on the concentration of the corresponding compounds, but also on the intensity of their mass spectral fragmentation, the data given in the table is not a true quantification but can be used for comparisons between the fractions. The fraction (F1) was found to be dominated by alkanes (74.8%) with decane (44.1%), undecane (24.6%) and nonane (6.1%) as the main constituents. Other components identified in this fraction were 1, 8-cineole, an ester and a phenolic compound (Table 1). The second fraction (F2) was dominated by alkanes (56.2%) with decane (24.9%), undecane (13%), tetradecane (10.0%) and hexadecane (8.3%) as the main components. Phthalic acid and 1, 8-cineole was also observed in this fraction. Phthalic acid is used mainly in the form of the anhydride in the production of dye, perfumes, saccharin, phthalates and many other industrial products. The fraction (F3) contains a high proportion of nonane (20.7%), terpenes (13.2%), ketones (1.4%) and an alcohol (0.7%). The prominent terpenes were α -terpinolene (7.2%) and limonene (3.0%). The fourth fraction (F4) was characterized by high proportion of terpenes (44.3%) dominated by the acyclic diterpene phytol (35.8%), α -terpinolene (6.3%) and loliolide (0.9%).

Table 1: Chemical composition of hexane fractions of the leaves of *Solanum pseudocapsicum*

| Constituents | Fractions (peak area %) ^b | | | | |
|---------------------------------|--------------------------------------|------|------|------|------|
| | KI ^a | F1 | F2 | F3 | F4 |
| Nonane | 899 | 6.1 | - | 20.7 | - |
| α -Pinene | 936 | - | - | 1.0 | - |
| Decane | 999 | 44.1 | 24.9 | 3.6 | 4.1 |
| α -Phellandrene | 1008 | - | - | 0.3 | - |
| Limonene | 1023 | - | - | 3.0 | 0.1 |
| 1, 8-Cineole | 1030 | 0.8 | 2.4 | 1.7 | - |
| α -Terpinolene | 1094 | - | - | 7.2 | 6.3 |
| Undecane | 1100 | 24.6 | 13.0 | - | - |
| Dodecane | 1200 | 2.4 | - | - | - |
| α -Terpineol | 1203 | - | - | 0.7 | - |
| Bornyl acetate | 1277 | 0.3 | 2.1 | - | - |
| Tetradecane | 1400 | 2.5 | 10.4 | - | - |
| Geranyl acetate | 1402 | - | - | 0.2 | - |
| β -Ionone | 1492 | - | - | 0.2 | - |
| Pentadecane | 1500 | 0.2 | - | - | - |
| Hexadecane | 1600 | 0.6 | 8.3 | - | - |
| 5-Octadecene | 1785 | 0.5 | 1.9 | - | - |
| Loliolide | 1800 | - | - | 1.0 | 0.9 |
| 2-Pentadecanone | 1821 | - | - | - | 1.3 |
| Methyl, 13-Methyltetradecanoate | 1829 | - | - | - | 0.3 |
| Hexadecanoic acid | 1983 | - | - | - | 8.3 |
| Phytol | 2096 | - | - | - | 35.8 |
| 9, 12-Octadecadienoic acid | 2157 | - | - | - | 2.4 |
| 9, 12, 15-Octadecatrienoic acid | 2186 | - | - | - | 9.0 |
| Octadecanoic acid | 2213 | - | - | - | 2.9 |
| Phthalic acid | 2741 | - | 8.0 | - | 15.2 |
| Total | | 81.5 | 71.0 | 39.6 | 81.2 |

^a Kovat's Index, ^b % of the total ion current

There was a high proportion of organic acids in this fraction (37.8%) dominated by phthalic acid (15.2%), 9, 12, 15-octadecatrienoic acid (9.0%) and hexadecanoic acid (8.3%).

The presence of a diterpene phytol in this fraction is worth noting, phytol was reported to be toxic and lethal (Steinberg *et al.*, 1966) and was reported to activate the peroxisome proliferator-activated receptor α (PPAR α) and regulates gene expression involved in lipid metabolism in PPAR α -expressing HepG2 hepatocytes (Goto *et al.*, 2005). The high proportion of fatty acids was also detected; fatty acids have been shown to cause death in rats and humans (Cnop *et al.*, 2001; Maedler *et al.*, 2001). Similarly, the delocalization of iron within the lung which contributed to both the chronic pulmonary inflammation and the carcinogenesis associated with smoking have been associated with fatty acids (Gao *et al.*, 2006). Hexadecanoic acid has been reported to induce apoptosis in hepatocytes (Wu and Cederbaum, 2003; Li Zhang *et al.*, 2005) and enhance lipid peroxidation of mitochondria (Diehl, 1999). The labilization of mitochondria and lysosomes after short exposures to fatty acids has also been reported (Wenzel and Hale, 1978). The high percentage of aliphatic hydrocarbons, terpenes and fatty acids could contribute significantly to the understanding of the biological characteristics of *S. pseudocapsicum* as a poisonous plant.

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REFERENCES

- Adams, R.P., 1989. Identification of Essential Oils by Ion Trap Mass Spectroscopy. New York, Academic Press.
- Badami, S., O.M. Prakash, S.H. Dungere and B. Suresh, 2005. *In vitro* antioxidant properties of *Solanum pseudocapsicum* leaf extract. Ind. J. Pharmacol., 37: 251-252.
- Batten, A. and H. Bokelmann, 1966. Wild Flowers of the eastern Cape Province. Cape and Transvaal Printers Limited. Cape Town.
- Boericke, W., 1927. Pocket Manual of Homeopathic, Materia Medica. 9th Edn., Boericke and Runyon, New York.
- Chakravarty, A.K., B. Das, E. Ali and S.C. Pakrashi, 1984. Studies on Indian medicinal plants part-77. Structure and stereochemistry of some new steroidal alkaloids from *Solanum pseudocapsicum* and *Solanum giganteum* by nuclear magnetic resonance spectroscopy. J. Chem. Soc. Perkin Trans., 1: 467-474.
- Cnop, M., J.C. Hannaert, A. Hoorens, D.L. Eizirik and D.G. Pipeleers, 2001. Inverse relationship between cytotoxicity of free fatty acids in pancreatic islet cells and cellular triglyceride accumulation. Diabetes, 50: 1771-1777.
- Der Marderosian, A.H., F.B. Giller and F.C. Rola, 1976. Phytochemical and toxicological screening of household ornamental plants potentially toxic to humans. J. Toxicol. Environ. Health, 1: 939-953.
- Diehl, A.M., 1999. Nonalcoholic steatohepatitis. Seminars in Liver Disease, 19: 221-229.
- Gao, X., M. Qian, J.L. Campian, D.R. Clark, T.J. Burke, J.W. Eaton and W.G. McGregor, 2006. Cytotoxic and mutagenic effects of tobacco-borne free fatty acids. Free Rad. Biol. Med., 40: 165-172.
- Goto, T.N., S. Takahashi, K. Kato and S. Egawa *et al.*, 2005. Phytol directly activates peroxisome proliferator-activated receptor α (PPAR α) and regulates gene expression involved in lipid metabolism in PPAR α -expressing HepG2 hepatocytes. Biochem. Biophys. Res. Com., 337: 440-445.
- Joulain, D. and K.A. Koenig, 1998. The Atlas of Spectra Data of Sesquiterpene Hydrocarbons. Hamburg, E. B. -Verlag.
- Li Zhang, J.J., P. Wang, Y.M. Mu and X.Y. Zhu *et al.*, 2005. Saturated free fatty acid, palmitic acid, induces apoptosis in fetal hepatocytes in culture. Exp. Toxicol. Pathol., 56: 369-376.
- Maedler, K., G.A. Spinas, D. Dynta and W. Moritz *et al.*, 2001. Distinct effects of saturated and monounsaturated fatty acids on beta-cell turnover and function. Diabetes, 50: 69-76.
- Steinberg, D., J. Avigan, C.E. Mize and J.H. Baxter *et al.*, 1966. Effects of dietary phytol and phytanic acid in animals. J. Lipid Res., 7: 684-691.
- Vijayan, P., H.C. Prashanth, V. Preethi and S.A. Dhanaraj *et al.*, 2003. Hepatoprotective effect of the total alkaloid fraction of *Solanum pseudocapsicum* leaves. Pharm. Biol., 41: 443-448.
- Vijayan, P., P. Vijayaraj, P.H. Setty and R.C. Hariharapura *et al.*, 2004. The cytotoxic activity of the total alkaloids isolated from different parts of *Solanum pseudocapsicum*. Pharm. Bull., 27: 528-30.
- Wenzel, D.G. and T.W. Hale, 1978. Toxicity of free fatty acids for cultured rat heart muscle and endothelioid cells. I. Saturated long-chain fatty acids. Toxicology, 11: 109-117.
- Wu, D. and A.I. Cederbaum, 2003. Role of p38 MAPK in CYP2E1-dependent arachidonic acid toxicity. J. Biol. Chem., 278: 1115-1124.