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Alkaloids in *Solanum torvum* Sw (Solanaceae)

(With 2 Tables & 1 Figure)

Alcaloides en Solanum torvum Sw (Solanaceae)

(Con 2 Tablas y 1 Figura)

Pérez-Amador[1] MC, V Muñoz Ocotero[1], JM García Castañeda[1], AR González Esquinca[2]

Abstract. A comparison was made between plants of *Solanum torvum* Sw that grow in Chiapas, Mexico, and plants of the same species originating from India. This was effected to establish either similarities or differences between these plants in total alkaloid contents and presence of solasodine, an important alkaloid for the partial synthesis of steroids. The total alkaloid content (0.12%) of the plants coming from Chiapas and India was the same. However, solasodine was found only in the plants of Chiapas. In addition, the total amount of glycoalkaloids (0.038%) and two glycosilated compounds derived from solasodine, solasonine (0.0043%) and solamargine (0.0028%), were determined.

Key words: Solanaceae, *Solanum torvum*, alkaloids, solasodine, solamargine.

Resumen. Se efectuó una comparación entre plantas de *Solanum torvum* Sw que crecen en Chiapas, México, y plantas de la misma especie que crecen en India. Esto se efectuó para establecer similitudes o diferencias entre

[1] Facultad de Ciencias, UNAM. Coyoacán 04510. México, D.F.
[2] Escuela de Biología (UNICACH) Tuxtla Gutiérrez, Chiapas. México.
Address correspondence to: Dr. Maria Cristina Pérez-Amador; Facultad de Ciencias. UNAM. Circuito Exterior s/n Ciudad Universitaria. C.P. 04510. México D.F.
e-mail: perez_amador@yahoo.com; mcpa@hp.fciencias.unam.mx
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estas plantas en el contenido de alcaloides totales y la presencia de solasodina, alcaloide importante en la síntesis parcial de esteroides. La cantidad de alcaloides totales (0,12%) fue la misma en las plantas de Chiapas que en las plantas de India, pero la solasodina se encontró solamente en las plantas de Chiapas. Además, se determinó la cantidad total de glicoalcaloides (0,038%) y de dos compuestos glicosilados derivados de solasodina, solasonina (0,0043%) y solamargina (0,0028%).

Palabras clave: Solanaceae, *Solanum torvum*, alcaloides, solasodina, solamargina.

INTRODUCTION

The family Solanaceae comprises about 80 genera and 3000 species, from which 15000 belong to the genus *Solanum*. This genus is widespread over the world although it is concentrated mainly in the tropics and subtropics. In Mexico, there are about 150 species. The genus has toxic alkaloids which are distributed in all parts of the plant (Cronquist, 1981). Several *Solanum* species contain free and glycosilated alkaloids, important substrates for the synthesis of steroidal hormones (Lewis et al., 1970; Maití et al., 1979), thus making this species very important economically.

In this work, we report the study of some aspects of the alkaloids of *Solanum torvum* grown in Chiapas, Mexico. One of our goals was to make a comparison of the alkaloid content of this Mexican plant with that of *Solanum torvum* grown in India (Maití et al., 1979). We wanted to observe if the differences in climate conditions and location have an influence on the total alkaloid content of this species. Maití (1979) also reported the presence of solasodine in other species of *Solanum*.

There are some species which contain a high amount of active glycoalkaloids, and in our study it was interesting to know the relation between free alkaloids-glycosilated alkaloids. Therefore, we also determined the amount of glycoalkaloids, and solasonine and solamargine (two glycosilated compounds of solasodine: Lewis et al., 1970), in *Solanum torvum*. These two compounds are the dominant steroidal glycoalkaloids in the genus *Solanum* (Ripperger, 1995).

MATERIALS AND METHODS

Plants were collected near Tuxtla Gutierrez (20 km on the road towards Ocosocoautla). The collected plant material was deposited at the Herbario de la Facultad de Ciencias, UNAM (FCME).

Extraction of total alkaloids. Dry and ground leaves (1 kg) were macerated with methanol (3x), and the extract filtered; the solvent was eliminated at a reduced pressure. The resulting dry extract was dissolved in 500 ml of 5% AcOH and washed several times with ether. Then it was extracted with $CHCl_3$ (v/v), dried with anhydrous sodium sulphate and the solvent eliminated at a reduced pressure (Lewis et al., 1970). Yield was 1.27 g (0.12%) of dry powder (total alkaloids).

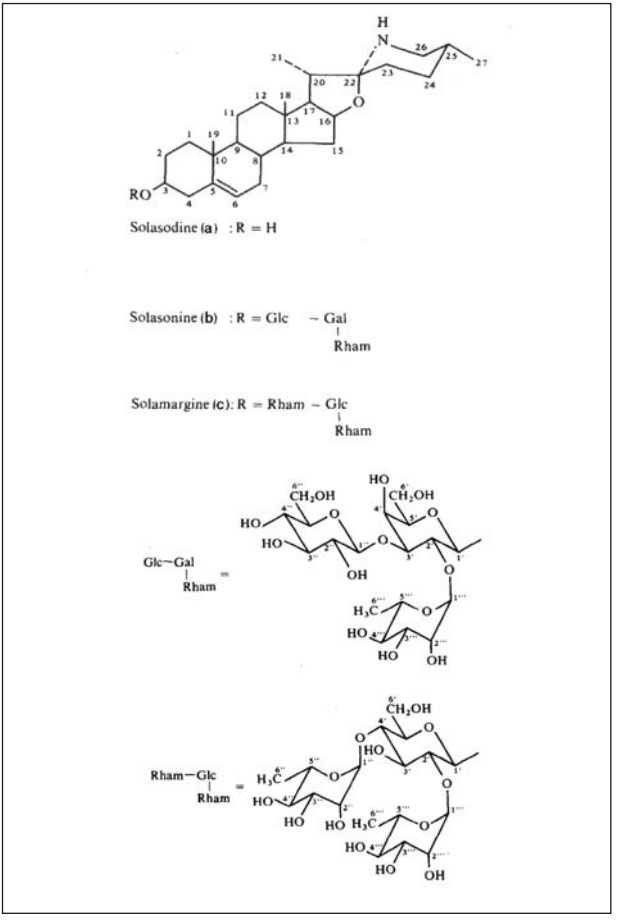
Identification of solasodine. A chloroform solution of the dry alkaloid extract (50 mg/ 10 ml) was applied on a silica gel Merck-60 plate (5 µl), using chloroform-methanol (95:5) as mobile phase. A solution of resorcinol was used as a spraying reagent (10 mg in 50 ml of a mixture of glacial acetic acid and sulphuric acid (1:1) (Briggs et al., 1942). The plate was heated and the alkaloid (Fig. 1a) was observed as a pink spot with an Rf value of 0.3 (Stahl, 1969; Nisit et al., 1999). Solasodine was isolated by preparative chromatoplate and identified by ^{13}C-NMR (Table 2a).

Identification of solasonine and solamargine. The glycoalkaloids were determined by TLC; 5 µl of the above solution were applied on a silica gel Merck-60 plate. The mobile phase was buthanol-diethylamine-methanol (85:10:2) and the spray reagent resorcinol. The alkaloids were observed as pink spots with Rf values of 0.28 (solasonine; Fig. 1b) and 0.4 (solamargine; Fig. 1c) in accordance with Lewis' values (Lewis et al., 1970). These compounds were identified by ^{13}C-NMR (Table 2 b and c).

Glycoalkaloid quantification. The dry extract of total alkaloids (1.27 g) was dissolved in 18 ml of ethanol. The ethanolic solution (15 ml) was applied in 2 preparative chromatoplates to separate solasonine and solamargine, and the plates were eluted with chloroform.

Fig. 1. Structure of solasodine and their glycosilated derivatives.

Fig. 1. *Estructura de solasodina y sus derivados glicosidados.*



The two obtained fractions gave 46 mg of solasonine (Fig. 1b) and 30 mg of solamargine (Fig. 1c). The standard curve was prepared with the 76 mg using 5 dilutions, which were read at 574 nm (Table 1).

Three ml of the above solution of total alkaloids were added to 3 ml of H_3PO_4 (88 %) and 1.5 ml (0.5 %) of AcOH to determine the alkaloid con-

Table 1. Standard curve of glycoalkaloids.
Tabla 1. *Curva estándar de glicoalcaloides.*

Tube	Concentration (mg / ml)	Absorbance (λ = 574 nm)
1	15.20	0.220
2	7.60	0.135
3	3.80	0.070
4	1.90	0.020
5	0.95	0.010

centration. The resulting solution was warmed at 50 °C for 15 minutes and read at 574 nm (absorbance 0.13). This absorbance was interpolated in the standard curve; the yield was expressed on a leaf dry weight basis: 382.8 mg (0.038 %) of glycoalkaloids.

RESULTS AND DISCUSSION

Alkaloids are one of the most important groups of secondary metabolites due to the great number of isolated products and their pharmacological activity. They have a restricted distribution and are readily affected by the plant growth location and atmospheric conditions. It is important to know if these factors can affect either the presence or absence of certain compounds, mainly if they have pharmacological properties.

In our comparison, plants grown in Chiapas had the same amount of total alkaloids (0.12%) as the species grown in India (Maiti et al., 1979), but the one from India did not have solasodine (Fig. 1a), an alkaloid which we found in the Chiapas' species. This alkaloid is important because it can be easily used as intermediate in the steroid synthesis (Sato et al., 1959).

In addition to the total alkaloid content (0.12%; expressed on a plant dry weight basis), we determined in *Solanum torvum* the total amount of glycoalkaloids (0.039%), solasonine (Fig. 1b) (12% yield, based on the 382.8 mg of total glycoalcaloids obtained), and solamargine (Fig. 1c) (7.8%

Table 2. ^{13}C NMR chemical shifts (δ) of solasodine (a), solasonine (b) and solamargine (c)

Tabla 2. *Cambios químicos (δ) identificados por ^{13}C NMR de solasodina (a), solasonina (b) y solamargina (c)*

Carbon No.	a		b		c
1	35.2		34.8		34.7
2	32.2		30.1		30.1
3	72.2		79.3		79.3
4	42.8		37.8		37.8
5	140		140.8		140.8
6	122.8		123		122.9
7	31.2		31.5		31.4
8	31.9		32		31.9
9	50.8		50.3		50.3
10	38		38.1		38.1
11	20.9		21.1		21.1
12	40.1		40.1		40.1
13	40.7		40.6		40.6
14	56.3		56.7		56.7
15	32.7		32.5		32.3
16	78.9		78.7		78.7
17	63.6		63.5		63.4
18	16.5		16.5		16.5
19	20.3		19.7		19.7
20	41.9		41.7		41.8
21	15.2		15.2		15.2
22	98.3		98.2		98.2
23	34.6		34.6		34.6
24	30		30.1		30.1
25	30.5		30.7		30.7
26	48.1		47.9		48
27	20.6		19.7		19.7
1'			100.1		100.2
2'			75.8		78.2
3'		galactose	84.8	glucose	72.5
4'			69.2		77.7
5'			74.4		76.7
6'			61.9		61.3
1''			105.1		100.7
2''			74.1		74.1
3''		glucose	78.7	rhamnose	72.2
4''			69.4		72.3
5''			78.1		69
6''			61.5		17.3
1'''			100.8		101
2'''			74.1		74.2
3'''		rhamnose	72.7	rhamnose	72.5
4'''			72.3		72
5'''			68.7		68.7
6'''			17.9		17.9

yield, based on the 382.8 mg of total glycoalkaloids obtained). These are two glycosilated compounds of solasodine (Fig. 1a), which could be used as a substrate for the production of important steroids in pharmacology.

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