PERGAMON

Phytochemistry 55 (2000) 787–792

PHYTOCHEMISTRY

www.elsevier.com/locate/phytochem

# Flavonoids from *Lonchocarpus latifolius* roots

Aderbal F. Magalhães [a,*], Ana Maria A. Tozzi [b], Eva G. Magalhães [b], Marisa A. Nogueira [a], Sônia C.N. Queiroz [a]

[a] *Instituto de Química, UNICAMP PO Box 6154, CEP, 13081 970 Campinas, Sao Paulo, Brazil*
[b] *Instituto de Biologia, UNICAMP, Campinas, Brazil*

Received 19 October 1999; received in revised form 29 March 2000

**Abstract**

From the petrol extract of *Lonchocarpus latifolius* roots, 10 flavonoids were isolated. These included: 3,5-dimethoxy-2″,2″-dimethylpyrano-(5″,6″:8,7)-flavone, 3-methoxy-(2″,3″:7,8)-furanoflavanone, 3′,4′-methylenedioxy-(2″,3″:7,8)-furanoflavanone, and (2,3-*trans*-3,4-*trans*)-3,4-dimethoxy-(2″,3″:7,8)-furanoflavan, as well as the previously known *karanjachromene, karanjin, lanceolatin* B, *pongachromene, pongaglabrone* and *ponganpin*. Only nine flavonoids could be quantified through HPLC analysis. 

*Keywords:* *Lonchocarpus latifolius*; Leguminosae; Roots; Flavone; Flavane; Flavanone

## 1. Introduction

Of the approx. 100 *Lonchocarpus* species in existence, 24 are native to Brazil (Magalhães et al., 1996). The literature contains reports on the chemistry of thirty-four species, all of which have furnished flavonoids. Of these *L. araripensis* (Do Nascimento and Mors, 1981), *L. nitidus* (Menichini et al., 1982; Gomes et al., 1981), *L. obtusus* (Gomes et al., 1981; Do Nascimento et al., 1976) and *L. sericeus* (Gomes et al., 1981; Mahmoud and Waterman, 1986; Delle Monache et al., 1977) are the only Brazilian species previously investigated by other research groups. *L. nitidus* (Menichini et al., 1982; Gomes et al., 1981) also belongs to the *Densiflori* section of the *Lonchocarpus* subgenus *Lonchocarpus* as does *L. latifolius*, and has furnished chalcones and flavanones. Thus, as part of a chemical study of previously univestigated Brazilian *Lonchocarpus* species occurring in Brazil (Magalhães et al., 1996, 1997), we now report the isolation and characterization of ten flavonoids (**1**–**10**) from the roots of *L. latifolius* which also furnished two dibenzoylmethane derivatives (**11** and **12**) described earlier (Magalhães et al., 1997).

## 2. Results and discussion

The petrol extract of *Lonchocarpus latifolius* roots on successive chromatographic analysis (column, TLC and preparative TLC) led to flavonoids **1**–**12** (Fig. 1). *Karanjachromene* **1** (Garcez et al., 1988), *karanjin* **2** (Lyra et al., 1979; Talapatra et al., 1982; Tanaka et al., 1992), *lanceolatin* B **3** (Lyra et al., 1979; Talapatra et al., 1982; Tanaka et al., 1992), *pongachromene* **4** (Garcez et al., 1979; Pelter et al., 1981), *pongaglabrone* **5** (Talapatra et al., 1982; Tanaka et al., 1992; Pelter et al., 1981) and *ponganpine* **6** (Lyra et al., 1979; Tanaka et al., 1992) were characterized by comparing their spectral data with literature values.

Compound **7** was obtained in very small amounts as a yellowish oil. Its $^1$H NMR spectrum (see Section 3) was very similar to that of *karanjachromene* (**1**), which also displayed characteristic absorptions for an unsubstituted B ring and a 2,2-dimethylpyran group. However, instead of H-5 and H-6 doublets, there was a singlet at $\delta$ 6.48 (1H, *s*) with signals at $\delta$ 3.87 (3H, *s*) and $\delta$ 3.88 (3H, *s*) indicating the presence of two methoxyl groups. From the three possible structures **7a**–**c**, structure **7a** was selected based on analysis of the NOE data shown in Fig. 2.

Compound **8** was obtained as a colourless amorphous powder. Its $^1$H NMR spectrum (Table 1) was very similar to that of *karanjin* (**2**), except for the presence of

* Corresponding author. Tel.: +55-19-788-3064; fax: +55-19-788-3023.
*E-mail address:* aderbal@iqm.unicamp.br (A.F. Magalhães).

0031-9422/00/$ - see front matter 
PII: S0031-9422(00)00300-9

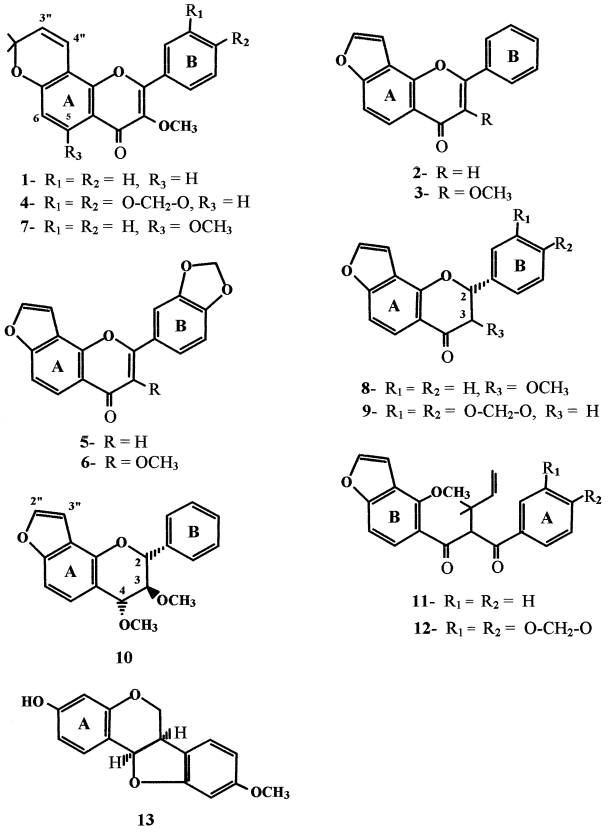


Fig. 1. Flavonoids isolated from *Lonchocarpus latifolius* roots.

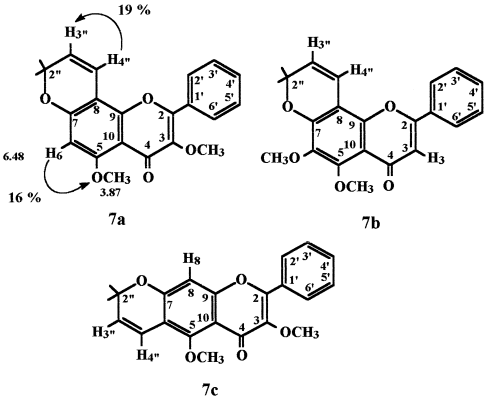


Fig. 2. Structural alternatives for compound **7**. Only **7a** is compatible with the NOE differential spectrum.

two doublets at $\delta$ 5.50 (1H, *d*, $J=10$ Hz) and $\delta$ 4.20 (1H, *d*, $J=10$ Hz), respectively, typical of H-2 and H-3 absorptions of a flavanonol derivative. The diamagnetic shift of one of the methoxyl groups ($\delta$ 3.42) was in agreement with that expected for a flavanonol 3-methyl ether. HR-EIMS indicated ($M^+=294.0894$ suggesting $C_{18}H_{14}O_4$), with mass spectral fragments **8a** [$m/z=160$] and **8b** [$m/z=134$], resulting from RDA cleavage of the C ring, and the fragment **8c** [$m/z=91$] (Fig. 3). All are diagnostic of flavanonol derivatives (Harborne et al., 1975) (Table 2).

Compound **9** was obtained as a viscous yellowish oil. The $^1$H NMR spectrum (Table 1) was very similar to that of *pongaglabrone* (**5**), except for an ABX system characteristic of H-2, H-3 *ax* and H-3 *eq* in a flavanone skeleton. Its mass spectrum gave a parent ion at [$M^+$, $m/z$ 308], with fragments **8a** [$m/z=160$] and **9a** [$m/z=148$] originating from C ring RDA cleavage. Additionally, the fragment **9b** [$m/z=149$] correspond to pathway II cleavage of the flavonoid skeleton (Fig. 3).

Compound **10** was obtained as colourless needles. The $^1$H NMR spectrum (Table 1) displayed absorptions for the hydrogens of A and B rings comparable to those of **8**. This time, however, two doublets at $\delta$ 5.03 (1H, *d*, $J=9.3$ Hz) and $\delta$ 4.73 (1H, *d*, $J=7.5$ Hz), together with a double doublet at $\delta$ 3.71 (1H, *dd*, $J=7.5$ and 9.3 Hz), corresponded to H-2, H-4 and H-3 absorptions of a 3,4-dioxygenated flavan. Signals at $\delta$ 3.00 (3H) and $\delta$ 3.60 (3H) showed that **10** was a 3,4-dimethoxyflavan derivative. The coupling constants observed for H-2 and H-4 are very close to those reported in the literature (Harborne et al., 1975) for the 2:3-*trans*-3:4-*trans* configuration. This was confirmed further by the NOE data obtained by irradiation of H-2 and H-4 (Fig. 4), which also permitted the correct assignment of the chemical shifts for H-2, H-4 as well as for each methoxyl group. The $^{13}$C NMR spectrum (see Section 3) and DEPT (90 and 135°) analysis gave signals corresponding to five quarternary carbons, 12 methines and 2 methyl groups. Signals at $\delta$ 80 (C-2), $\delta$ 81.98 (C-3) and $\delta$ 79.86 (C-4) confirm the presence of a 3,4-dioxygenated flavan skeleton. HR-EIMS gave a molecular ion at $M^+$ 310.1196 corresponding to $C_{19}H_{18}O_4$), with the most prominent mass spectral fragment corresponding to **10a** [$m/z=176$], and **8b** [$m/z=134$ RDA cleavage of C ring] and **8c** [$m/z=91$] (Fig. 3).

The dichloromethane extract of *Lonchocarpus latifolius* roots on chromatographic analysis (column and prep TLC) also led to isolation of *medicarpin* **13** (Fig. 1) identified by comparing its spectral data with literature values (Afzail and Al-Oriquat, 1986).

The petrol, dichloromethane and methanol extracts obtained from roots of *L. latifolius* were also submitted to the brine shrimp lethality (Table 2) (Meyer, 1982) and bioautography tests (Magalhães et al., 1998). The petrol and dichloromethane extracts were active against *Bacillus subtilis, Aspergillus niger* and *Rhizopus oryzae*, whereas compound **11** was active against *B. subtilis, A. niger* and *Cladosporium cladosporioides* (Magalhães et al., 1998). The brine shrimp lethality and the insecticidal activity (World Health Organization No. 443, 1970) results are noted, respectively in Tables 3 and 4.

The mean oxidation vs methylation values (O/M) of the flavonoids in the petrol extracts from the roots of *L. subglaucescens* (Magalhães et al., 1996) and *L. latifolius* suggest that *L. subglaucescens* is more highly evolved than *L. latifolius* as deduced previously on the basis of

Table 1
$^1$H NMR spectral data (300 MHz, $CDCl_3$) for compounds **8**, **9** and **10**

| | **8** | **9** | **10** |
|---|---|---|---|
| H-2 | 5.50 (1H, *d*, *J* = 10) | 5.53 (1H, *dd*, *J* = 3; 13)<br>2.90 *eq* (1H, *dd*, *J* = 3; 17) | 5.03 (1H, *d*, *J* = 9.3) |
| H-3 | 4.20 (1H, *d*, *J* = 10) | 3.10 *ax* (1H, *dd*, *J* = 13; 17) | 3.71 (1H, dd, J = 7.5; 9.3) |
| H-4 | – | – | 4.73 (1H, *dd*, *J* = 7.5; 9.3) |
| H-5 | 7.88 (1H, *d*, 9) | 7.89 (1H, *d*, *J* = 9) | 7.34 (1H, *d*, *J* = 9) |
| H-6 | 7.23 (1H, *dd*, *J* = 1; 9) | 7.20 (1H, *dd*, *J* = 1; 9) | 7.18 (1H, *dd*, *J* = 1; 9) |
| H-2′ | 7.54 (2H, *dd*, *J* = 2; 8) | 7.05 (1H, *d*, *J* = 2) | |
| H-3′ | | | |
| H-4′ | 7.4–7.5 (3H, *m*) | – | 7.4–7.5 (5H, m) |
| H-5′ | | 6.87 (1H, d, J = 8) | |
| H-6′ | 7.54 (2H, *dd*, *J* = 2; 8) | 6.97 (1H, *dd*, *J* = 2; 8) | |
| H-2″ | 7.62 (1H, *d*, *J* = 2) | 7.60 (1H, *d*, *J* = 2) | 7.56 (1H, *d*, *J* = 2) |
| H-3″ | 6.93 (1H, *dd*, *J* = 1; 2) | 6.93 (1H, *dd*, *J* = 1; 2) | 6.81 (1H, *dd*, *J* = 1; 2) |
| H-1‴ | – | 6.03 (2H, *s*) | – |
| $OCH_3$ | 3.42 (3H, *s*) | – | 3.00 (3H, *s*) |
| $OCH_3$ | – | – | 3.60 (3H, *s*) |

[d] = Doublet; *dd* = double doublet; *m* = multiplet; *s* = singlet; *J* = coupling constant in Hertz.

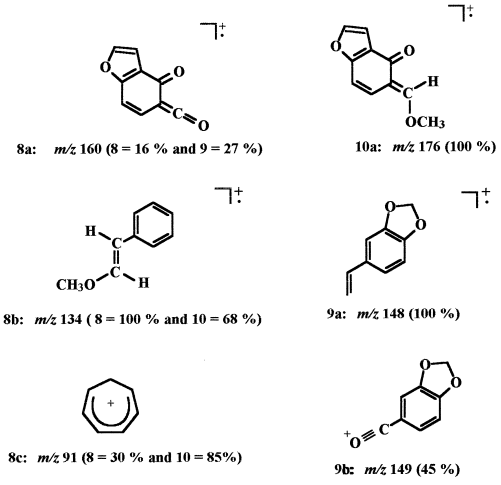


Fig. 3. Fragment ions corresponding to prominent peaks observed in the mass spectra of compounds **8**, **9** and **10**.

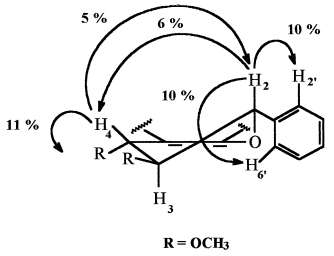


Fig. 4. NOE differential spectrum data of **10**, enhancements observed by irradiation of H-2 and H-4.

Table 2
Brine shrimp lethality test results for extracts from *Lonchocarpus latifolius* roots and compound **11**

| Preparation | LC 50 ($\mu g/ml^{-1}$) |
|---|---|
| Petrol extract | 0.1 |
| $CH_2Cl_2$ extract | 6.98 |
| MeOH extract | 9.25 |
| Compound **11** | 2.69 |
| Control ($H_2O$) | > 1000 |

morphological criteria (Table 5). The (O/M) values of each species of flavonoids has been considered as an indirect expression of the corresponding redox potential and has been claimed as an useful approach for analyzing evolution trends in *Lonchocarpus–Derris* complex (Gottlieb, 1972).

HPLC analysis of petrol dichloromethane and methanol extracts of roots from the same plant collected in August 1994 and 1996 showed a very similar chromatographic profile; however, only the dichloromethane and methanol extracts of the 1994 collection contained medicarpin (**13**).

HPLC of the petrol extract from the stems leaves and seeds collected in February 1997 showed that the petrol extract from leaves and seeds consisted mainly of lanceolatin B (**3**) and 8-(α,β-dimethylallyl)-pongamol (**11**), while that of stems did not exhibit peaks corresponding to pongaglabrone (**5**) and (**10**).

Karanjin (**2**), lanceolatin B (**3**) and 8-(α,β-dimethylallyl)-pongamol (**11**) were the most abundant flavonoids in the petrol extract of root samples collected in 1994 and in 1996 (Tables 6 and 7),while 8-(α,α-dimethylallyl)-pongamol (**11**) was the main flavonoid in the petrol extracts of stems, leaves and seeds (Table 7). The highest concentration of medicarpin (**13**) was observed in the methanol extract from root samples collected in 1994 (Table 6).

Table 3
Insecticidal test with *Aedes aegypti* for extracts from *Lonchocarpus latifolius* roots

| Extract | Solvent | Concentration (ppm) | No. of larvae | No. of larvae died | % Mortality | CL 50 (ppm) | CL 90 (ppm) |
|---|---|---|---|---|---|---|---|
| MLR[a] | Methanol | 5.6 | 200 | 45 | 22.5 | | |
| | | 13 | 200 | 118 | 59.0 | 10.89 | 86.88 |
| | | 24 | 250 | 202 | 80.8 | | |
| EPLR | Acetone | 0.001 | 75 | 26 | 34.7 | | |
| | | 0.01 | 125 | 73 | 58.4 | 0.0043 | 13.3 |
| | | 0.1 | 174 | 144 | 82.3 | | |
| Control | Acetone | – | 475 | 3 | 0.6 | | |
| Control | Methanol | – | 225 | 2 | 0.9 | | |
| Control | $H_2O$ | – | 375 | 3 | 0.8 | | |

[a] MLR, methanol extract; EPLR, petrol extract.

Table 4
Mean oxidation vs methylation values (O/M) from *Lonchocarpus latifolius* and *Lonchocarpus subglaucescens*

| Species | O/M |
|---|---|
| *Lonchocarpus latifolius* | +1.75/+1.33 |
| *Lonchocarpus subglaucescens* | +2.8/+2.1 |

Table 5
Flavonoid contents of extracts of *Lonchocarpus latifolius* roots collected in August 1994

| | Flavonoid contents in roots (mg/g) extracts | | |
|---|---|---|---|
| Flavonoid | Petrol | Dichloromethane | Methanol |
| **1** | 2.13 | – | – |
| **2** | 0.90 | – | – |
| **3** | 2.02 | – | – |
| **4** | 0.39 | – | – |
| **5** | 0.72 | – | – |
| **6** | 0.70 | – | – |
| **10** | 0.16 | – | – |
| **11** | 8.05 | – | – |
| **13** | – | 1.62 | 7.03 |

Seasonal analysis made by HPLC of petrol extracts from root samples of one plant collected in August 1996 (winter), as well as September 1996 (spring) and February 1997 (summer) showed that the highest concentration of flavonoids occurred in the spring. 8-(α,β-Dimethylallyl)-pongamol (**11**) was by far the most abundant flavonoid; its concentration was not significantly affected by the season, while 3,4-dimethoxyflavan (**10**) was the least abundant among the nine quantified flavonoids (Table 7).

Table 6
Seasonal variation of flavonoids in *Lonchocarpus latifolius* roots (petrol extract)

| | Flavonoid content in roots (mg/g) | | |
|---|---|---|---|
| Flavonoid | August 1996 (Winter) | November 1996 (Spring) | February 1997 (Summer) |
| **1** | 0.47 | 0.87 | 0.12 |
| **2** | 0.27 | 0.92 | 0.26 |
| **3** | 0.46 | 1.95 | 0.66 |
| **4** | 0.00 | 0.26 | 0.09 |
| **5** | 0.20 | 0.31 | 0.12 |
| **6** | 0.18 | 0.39 | 0.12 |
| **10** | 0.04 | 0.13 | 0.03 |
| **11** | 1.86 | 2.30 | 1.61 |

Table 7
Flavonoid contents in stems, leaves and seeds of *Lonchocarpus latifolius* collected in 1997 (petrol extract)

| | Flavonoid contents (mg/g) | | |
|---|---|---|---|
| Flavonoid | Stems | Leaves | Seeds |
| **1** | 0.40 | – | – |
| **2** | 0.67 | – | – |
| **3** | 0.29 | 1.08 | 0.33 |
| **4** | 0.21 | – | – |
| **5** | – | – | – |
| **6** | 0.32 | – | – |
| **10** | – | – | – |
| **11** | 1.48 | 3.67 | 1.02 |

## 3. Experimental

### 3.1. Plant material

Roots of *Lonchocarpus latifolius* were collected at Santa Elisa Farm of the Instituto Agronômico de Campinas, in August 1994, August 1996, November 1996 and February 1997. Voucher specimens were deposited at the herbarium (UEC 21974) of Campinas State University, Campinas-SP, Brazil.

### 3.2. General extraction and isolation procedure

Dried roots (714 g) of *L. latifolius* were successively extracted with petrol (30–60°C), $CH_2Cl_2$ and MeOH for

60 h in a Soxhlet apparatus. After solvent evaporation, the petrol extract was a viscous yellow oil (12.5 g), whereas the dichloromethane extract (7.5 g) and the methanol extract (43 g) were brown gums. A portion of the petrol extract (6 g) was subjected to 240 g silica gel chromatography, eluted first with petrol. The eluent polarity was then gradually increased by addition of $CH_2Cl_2$, EtOAc and MeOH to furnish 283 fractions (200 ml each) which were reduced to 43 fractions following TLC analysis. Most of the compounds of interest were present in 12 groups ranging from fractions 56 to 156. Each fraction was further submitted to prep. TLC, eluted with petrol–EtOAc 8:2 v/v permitting the isolation of **1** (14 mg), **2** (155 mg), **3** (38 mg), **4** (7 mg), **5** (8 mg), **6** (5 mg), **7** (3 mg), **8** (2 mg), **9** (3 mg), **10** (5 mg), **11** (200 mg) and **12** (3 mg), respectively.

### 3.3. Compound 7 (3,5-dimethoxy-2″,2″-dimethylpyrano-(5″,6″:8,7)-flavone)

Viscous yellowish oil. $^1$H NMR (300 MHz, DMSO-$d_6$): $\delta$ 1.45 (6H, *s*, $CH_3$), 3.87 (3H, *s*, $OCH_3$), 3.88 (3H, *s*, $OCH_3$), 5.79 (1H, *d*, $J=10$ Hz, H-3″), 6.48 (1H, *s*, H-6), 6.89 (1H, *d*, $J=10$ Hz, H-4″), 7.5–7.6 (3H, *m* H-3′, H-4′ and H-5′), 8.03 (2H, *d*, $J=8$ Hz, H-2′ and H-6′).

### 3.4. Compound 8 (3-methoxy-(2″,3″:7,8)-furanoflavanone)

Colourless amorphous powder. UV $\lambda_{max}^{EtOH}$ nm (log $\varepsilon$) 240 (4.74). HR-EIMS, *m*/*z* found 294.0894; calcd. 294.0892 for $C_{18}H_{14}O_4$; EIMS *m*/*z* (rel. int.): 294 (9); 160 (16); 134 (100); 105 (4); 91 (30); 77 (9). $^1$H NMR (Table 1).

### 3.5. Compound 9 (3,4methylenedioxy-(2″,3″:7,8)-furano-flavanone)

Viscous yellowish oil. UV $\lambda_{max}^{EtOH}$ nm (log $\varepsilon$) 238 (4.61). IR $\nu_{max}$ cm$^{-1}$ (KBr): 2922, 2852, 1700, 1678, 1459, 1089. EIMS *m*/*z* (rel. int.) 308 (20); 160 (18); 149 (13); 148 (100); 132 (4). $^1$H NMR (Table 1).

### 3.6. Compound 10 (2,3-trans-3,4-trans)-3,4-dimethoxy-(2″,3″:7,8)-furano-flavan)

Needles, melting point: uncorr. 81.9–82.2°C. $[\alpha]_{20}^{D}=+21°$ ($c=0.4$ $CH_2Cl_2$). UV $\lambda_{max}^{EtOH}$ nm (log $\varepsilon$) 248 (4.43). IR $\nu_{max}$ cm$^{-1}$ (KBr): 2926, 2856, 2925, 1622, 1474, 1142, 1067. HR-EIMS, *m*/*z* found 310.1196; calcd. 310.1205 for $C_{19}H_{18}O_4$; EIMS *m*/*z* (rel. int.): 310 (2), 176 (100), 161 (64), 147 (47), 134 (68), 134 (105 (15), 91 (85), 77 (38). $^1$H NMR (Table 1). $^{13}$C NMR (75 MHz, $CDCl_3$ $\delta$) C-2 (80.50), C-3 (81.96), C-4 (79.86), C-5 (105.15), C-6 (124.19), C-7 (156.04), C-8 (116.70), C-9 (147.90), C-10 (115.36), C-1′ (138.13), C-2′ (127.19), C-3′ (128.36), C-4′ (128.44), C-5′ (128.36), C-6′ (127.19), C-2″ (144.00), C-3″ (104.09), $OCH_3$ (57.79; 59.53).

### 3.7. HPLC analysis

Before use as a standard, each isolated flavonoid was purified by semi-preparative HPLC (UV detection; $\lambda=240$ nm), using an ODS column (250 mm×10 mm i.d.) with a solvent gradient of $H_2O$–$CH_3CN$ (of 0–100% $CH_3$ CN; 60 min; 1.0 ml min$^{-1}$). An aliquot (2 μl) of each extract (petrol extract from roots, stems, seeds and leaves and dichloromethane extract from roots) was analysed by HPLC (UV detection; $\lambda=240$ nm) using an ODS column (100 mm×4.6 mm i.d.) eluted with a $H_2O$–$CH_3CN$ gradient (20–80% $CH_3CN$; 30 min; 0.8 ml min$^{-1}$). The peaks in the chromatograms were identified by co-injection of each standard compound mentioned above, being found the $R_T$ (in min) for **1** (19.08); **2** (15.27); **3** (14.08); **4** (18.23); **5** (13.61); **6** (14.71); **10** (17.52); **11** (18.84); **13** (11.30), respectively.

An aliquot (2 μl) of the methanol extract was also analysed by using an ODS column (100 mm×4.6 mm i.d.) eluted with a solvent gradient of $H_2O$–MeOH (3:97–0:100; 30 min; 0.8 ml min$^{-1}$).

Quantification of flavonoids in the extracts was made through the method of external calibration with correlation coefficients of 0.999.

## Acknowledgements

The authors are grateful to CAPES for scholarships awarded to M.A.N., to FAPESP for financial support and to Dr. Alfredo M. de O. Filho, Dr. Marli T.V. de Melo and Celso E. Santos (NPPN-UFRJ) for the insecticidal testing.

## References

Afzail, M., Al-Oriquat, G., 1986. Proton magnetic resonance spectra of petrocarpan and related phytoalexins. Heterocycles 24 (10), 2911–2941.

Delle Monache, F., Cairo Valera, G., Sialer Zapata, D., Marini-Bettolo, G.B., 1977. 3-Aryl-4-methoxycoumarins and isoflavonoids from *Derris glabrescens*. Gazz. Chim. Ital. 107 (78), 403–407.

Do Nascimento, M.C., Mors, W.B., 1981. Flavonoids of *Derris Araripensis*. Phytochemistry 20 (1), 147–156.

Do Nascimento, M.C., De Vasconcelos Dias, R.L., Mors, W.B., 1976. Flavonoids of *Derris obtusa* auronas and auronols. Phytochemistry 15, 1553–11558.

Gomes, C.M.R., Gottlieb, O.R., Marini Bettolo, G.B., Delle Monanche, F., Pollhil, R.M., 1981. Systematic significance of flavonoids in *Derris* and *Lonchocarpus*. Biochemical Systems Ecology 9 (2–3), 129–147.

Garcez, F.R., Scramin, S., do Nascimento, M.C., Mors, W.B., 1988. Prenylated flavonoids as evolutionary indicators in genus *Dahlstedtia*. Phytochemistry 27 (4), 1079.

Gottlieb, O.R., 1972. Micromolecular evolution, Systematics and Ecology. Springer, New York.

Harborne, J.B., Mabry, T.J., Mabry, H., 1975. The Flavonoids. Academic Press, New York.

Insecticide Resistance and Vector Control, 1970. World Health Organization Technical Report Series, No. 443.

Lyra, D.A., De Mello, J.F., Delle Monache, G., 1979. Flavonoids from *Derris mollis*. Gazzeta Chimica Italiana 109 (1–2), 93–94.

Magalhães, A.F., Tozzi, A.M.A., Magalhães, E.G., Nogueira, M.A., Floréz-Roncancio, V.J., 1998. Ensayos Biológicos com Extratos Obtenidos de Raíces de *Lonchocarpus latifolius* y de um Nuevo Dibenzoilmetano Aislado. Ceres 45 (260), 351–358.

Magalhães, A.F., Tozzi, A.M.A., Magalhães, G.E., Blanco, I.S., Nogueira, M.A., 1997. Three dibenzoylmethane derivatives from *Lonchocarpus*species. Phytochemistry 46 (6), 1029–1033.

Magalhães, A.F., Tozzi, A.M.A., Sales, B.H.L.N., Magalhães, E.G., 1996. Twenty three flavonoids from *Lonchocarpus subglaucescens*. Phytochemistry 42 (5), 1459–1471.

Mahmoud, E.H.N., Waterman, P.G., 1986. Flemistrictin-B: a chalcone from seeds of *Lonchocarpus sericeus*. Journal Natural Products 49 (6), 1179– 1180.

Menichini, F., Delle Monanche, F., Marini Bettolo, G.B., 1982. Flavonoids and rotenoids from *Tephrosieae* and related tribes of Leguminosae. Planta Medica 45 (4), 243–244.

Meyer, B.N., 1982. Brine-shrimp: a convenient biossay for active plant constituents. Planta Medica 45 (1), 31–34.

Pelter, A., Ward, R.S., Venkata Rao, E., Raju Ranpa, N.J.C.S., 1981. 8-Substituted flavonoids and 3-substituted 7-oxygenated chalcones from *Tephrosia purpurea*. Journal of the Chemical Society Perkin 1 9, 2491–2498.

Talapatra, S.K., Mallik, A.K., Talapatra, B., 1982. Isopongaglabrol and 6-methoxiisopongaglabrol, two new hydroxyfuranoflavones from *Pongamia glaba*. Phytochemistry 21 (3), 761–766.

Tanaka, T., Iinura, M., Kaoru, Y.E., 1992. Flavonoids in root bark of *Pongamia pinnata*. Phytochemistry 31 (3), 993–998.