

BRIEF COMMUNICATION

ANTI-TRYPANOSOMAL ACTIVITY OF PENTACYCLIC TRITERPENES ISOLATED FROM *Austroplenckia populnea* (CELASTRACEAE)

Lucienir Pains DUARTE(1), Sidney Augusto VIEIRA FILHO(1,3), Grácia Divina de Fátima SILVA(1), José Rego de SOUSA(1) & Artur da Silveira PINTO(2)

SUMMARY

Four pentacyclic triterpenes isolated from *Austroplenckia populnea* and four compounds of known anti *T. cruzi* or anti-malarial activity were tested. Of those triterpenes tested 20 α -hydroxy-tingenone showed high activity, epikatononic acid was less active, while populnilic and populnic acids were inactive against the trypanosome of the subgenus *Schizotrypanum* tested. Benzonidazole, nifurtimox, ketoconazole and primaquine presented a remarkable dose-dependent inhibitory effect reaching practically to a total growth inhibition of the parasite at the end of incubation time. The trypanosome tested appear to be a suitable model for preliminary screen for anti *T. (S.) cruzi* compounds.

KEYWORDS: *Austroplenckia populnea*; Pentacyclic triterpenes; Anti-trypanosomal activity; Growth inhibition.

Austroplenckia populnea Reiss (Celastraceae) is a tropical tree commonly found in the Minas Gerais State, Brazil. "Mangabarana, "Mangabeira-Brava", and "Marmelinho do Campo" are its popular names. The tea of its leaves is used as antidiarrheal² and anti-rheumatic⁶ in the popular medicine. Extracts and several constituents obtained from *A. populnea* have been investigated for biological activity including antitumor activity⁸, as well as, antibacterial activity^{11,16}.

On the other hand, Chagas' disease remains a major public health problem in Latin America where it has been estimated that 16-18 millions people are chronically infected by *Trypanosoma cruzi*, its etiological agent¹⁷.

Since reduviid bugs (mainly the domiciate species *Triatoma infestans*), are intermediate hosts for *T. cruzi*, control is largely carried out by use of residual insecticides in endemic areas. However, efficacy of this activity is limited by economic-social factors¹. The chronicity combined with the involvement of the host's immune response in the pathogenesis of Chagas' disease makes the development of a effective vaccine particularly difficult. On the other hand, chemotherapy using the nitrofurantoin derivative nifurtimox or the nitroimidazole derivative benznidazole because of their clinical effects continue inexpressive and controversial¹⁴, claiming for new drugs.

In order to avoid handling the pathogenic *T. cruzi* for preliminary screening of anti-*T. cruzi* organic compounds GABORAK *et al.*³, had

earlier suggested the use of other members of the *Schizotrypanum* genus instead of, since a number of compounds of known anti-*T. (S.) cruzi* activity had showed similar activity when tested *in vitro* against non-pathogenic trypanosomes.

In the present study we used a trypanosome of the genus *Schizotrypanum* [*T. (S.) cruzi*] isolated from a *Phyllostomus hastatus* bat collected in Minas Gerais State, Brazil⁹, to test pentacyclic triterpenes isolated from *A. populnea*. This isolate was unable to produce detectable parasitemia in mice⁹, and distinct from *T. cruzi* in their isoenzymatic and lectin agglutination profiles^{10,15}. In addition, trials *in vitro* are of permanent interest because the identification of active compounds may be useful for the development of new agents for the treatment of Chagas' disease.

A. populnea Reiss (Celastraceae) was collected in Nova Lima region, Minas Gerais State, Brazil. After botanical identification by Dr. Luiz Pedersoli, Department of Botany, Universidade Federal de Minas Gerais, a voucher specimen (No. 10473) representing this collection has been deposited at the Herbarium of the Natural History Museum of the Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, Minas Gerais, Brazil.

The cleaned bark wood (3.0 kg) and roots (270 g) of *A. populnea* was dried at room temperature and then milled in powder. The bark wood was submitted to extraction using methanol. This extract (656 g)

(1) Núcleo de Estudo de Plantas Mediciniais (NEPLAM), Departamento de Química, ICEx -UFMG, MG, Brasil.

(2) Departamento de Microbiologia, ICB, UFMG, Caixa postal 486, 31270-010 Belo Horizonte, MG, Brasil.

(3) DEFAR, Escola de Farmácia, UFOP.

Correspondence to: Artur da Silveira Pinto, E-mail address: dasilvei@mono.icb.ufmg.br

was further fractionated with hexane, benzene and ethyl acetate. The roots were extracted with petroleum ether, dichloromethane and methanol. The phytochemical methods were described previously^{12,13}. From the petroleum ether extract of the roots was isolated 48.0 mg of the 20 α -hydroxy-tingenone¹², and from the bark wood extracts were isolated 209.4 mg of populnic acid 361.0 mg of epikatonic acid and 46.0 mg of populnic acid¹³.

The trypanosome strain [*T.(S) cruzi*] used in the experiments was isolated from a *P. hastatus* bat collected in Serrania, Minas Gerais State, Brazil. Isolation was performed by hemoculture in brain-heart-infusion (BHI) culture medium supplemented with 10% (v/v) heat-inactivated foetal bovine serum (FBS), 2% of 10% rabbit haemoglobin solution. Clone was obtained by successive plating technique in the same culture medium added with 0.75 agar. Flagellate was maintained by serial passage every 10 days and also by criopreservation in liquid nitrogen after addition of 10% glycerol (v/v) to culture.

Four pentacyclic triterpenes 20 α -hydroxy-tingenone, epikatonic acid, populnic acid and populnic acid were assayed (Table 2). Benzimidazole, nifurtimox, ketoconazole and primaquine drugs of known anti-trypanosomal, anti-fungal and anti-malarial activity were tested for comparison (Table 1).

T. (S) cruzi growth inhibition experiments were carried out in 16 x 150 mm screw-capped tubes containing of BHI medium added with 10% of foetal bovine serum (FBS) and 2% of a 10 mg/mL hemine (Sigma Co. US) solution, pH 7.2. The compounds (10 and 50 μ g/mL) tested were previously solubilized in DMSO (Dimethyl sulfoxide), filtered in Milipore (0.2 μ m) membrane and aseptically added to the tubes (0.1 mL/tube). In no-added control test tubes 0.1 mL of the solvent was added. Final volumes of *T.(S) cruzi* culture medium/tube was always 2.5 mL.

Inocula consisted of 0.1 mL of a exponential growth phase culture which correspond to about 4.8 x 10² cells/mL. Cultures were incubated at 28 °C for 2-12 days. Growth was estimated with heamocytometer (Improved Double Neubauer). Cell motility and cellular integrity was observed by microscopical observation in fresh-smears.

The results obtained in these experiments were given in tables 1 and 2. Table 1 presents the effects of the well-known *T. (S.) cruzi* growth inhibitors drugs nifurtimox, benzimidazole, ketoconazole and primaquine¹, on the epimastigote forms of the *T. (S.) cruzi*-like trypanosome used. It can be seen that, for all assayed drugs occurred a remarkable dose-dependent inhibitory effect reaching practically to a total parasite growth inhibition, at the end of the incubation time. Those results are agreements with the GABORAK *et al.*³ observation, and we can conclude that the trypanosome used appear to be a suitable model for the preliminary screen of anti-*T. cruzi* drugs, mainly in less-equipped laboratory in developing countries.

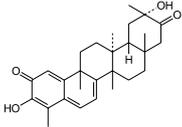
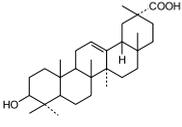
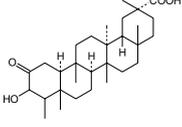
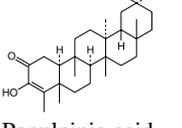
The activity of those pentacyclic triterpenes from *A. populnea* tested may be classified as follows; a) highly active: 20 α -hydroxy-tingenone, b) less active: epikatonic acid; and c) inactive: populnic acid and populnic acid (Table 2). Tingenone (Maitenine) other natural quinonoid⁵, that differs from 20 α -hydroxy-tingenone only by the presence of a methyl instead of the hydroxyl group at 20-position, inhibited *T. (S.) cruzi* growth mainly by DNA double-strand intercalation mechanism¹⁷. Otherwise, the presence of a carboxylic group at the 20-position, such as in epikatonic acid, populnic acid or populnic acid rises loss of activity, possible by difficulties in cross cell cytoplasmatic membrane. Frequently changes in critical radicals affect markedly the drug activity, such as in primaquine in which the 6-methoxy group was found to be responsible for the toxic effect, since analogues which have different substituents at this position are inactive against *T. (S.) cruzi*⁴.

Table 1
Inhibition growth* of *Trypanosoma (Schizotrypanum)* sp, isolated from bat *Phyllostomus hastatus*, by drugs with known anti-*T. cruzi* activity

Drug	Conc. μ g/mL	Culture time (Hours after inoculation)					
		48		96		192	
		Cell count	Inhibition (%)	Cell count	Inhibition (%)	Cell count	Inhibition (%)
Benzimidazole	00	1.0x10 ⁶	-	1.4x10 ⁶	-	7.3x10 ⁶	-
	10	4.9x10 ⁵	51.0	6.9x10 ⁵	50.7	8.2x10 ⁵	88.8
	50	4.5x10 ⁵	55.0	3.6x10 ⁵	74.3	3.0x10 ⁵	95.9
Ketoconazole	00	1.1x10 ⁶	-	1.3x10 ⁶	-	7.0x10 ⁶	-
	10	6.3x10 ⁵	42.7	7.2x10 ⁵	44.6	8.0x10 ⁵	88.6
	50	3.0x10 ⁵	72.7	1.0x10 ⁵	92.8	0.0	100.0
Nifurtimox	00	1.0x10 ⁶	-	1.4x10 ⁶	-	7.3x10 ⁶	-
	10	2.5x10 ⁵	75.0	4.5x10 ⁵	96.8	0.0	100.0
	50	5.0x10 ⁴	95.0	0.0	100.0	0.00	100.0
Primaquine	00	1.1x10 ⁶	-	1.3x10 ⁶	-	7.0x10 ⁶	-
	10	2.7x10 ⁵	75.5	4.0x10 ⁴	96.9	0.0	100.0
	50	7.5x10 ⁴	93.2	0.0	100.0	0.0	100.0

*The results represent three replicates of each experiment with mean values expressed as cell number/mL and % inhibition of growth.

Table 2
Inhibition growth* of *Trypanosoma (Schizotrypanum) sp.*, isolated from bat *Phyllostomus hastatus*, by four pentacyclic triterpenes isolated from *Austroplenckia populnea*

Substance	Conc. µg/mL	Culture time (Hours after inoculation)					
		48		96		192	
		Cell count	Inhibition (%)	Cell count	Inhibition (%)	Cell count	Inhibition (%)
 20α-hydroxy-tingenone	00	5.7x10 ⁵	-	6.0x10 ⁵	-	1.1x10 ⁶	-
	10	2.0x10 ⁵	64.9	2.0x10 ⁵	66.7	2.1x10 ⁵	80.0
	50	2.6x10 ⁵	54.4	2.0x10 ⁵	66.7	2.0x10 ⁵	81.8
 Epikatonic acid	00	7.0x10 ⁵	-	1.0x10 ⁶	-	2.0x10 ⁶	-
	10	6.9x10 ⁵	1.4	1.0x10 ⁶	0.0	1.9x10 ⁶	5.0
	50	6.8x10 ⁵	2.9	6.0x10 ⁵	40.0	3.2x10 ⁵	84.0
 Populnilic acid	00	7.0x10 ⁵	-	1.0x10 ⁶	-	2.0x10 ⁶	-
	10	6.7x10 ⁵	4.3	1.1x10 ⁶	0.0	1.9x10 ⁶	5.0
	50	6.5x10 ⁵	7.1	1.0x10 ⁶	0.0	1.9x10 ⁶	5.0
 Populnic acid	00	7.0x10 ⁵	-	1.0x10 ⁶	-	2.0x10 ⁶	-
	10	7.0x10 ⁵	0.0	9.7x10 ⁵	3.0	2.0x10 ⁶	0.0
	50	6.8x10 ⁵	2.9	9.8x10 ⁵	2.0	1.9x10 ⁶	5.0

*The results represent three replicates of each experiment with mean values expressed as cell number/mL and % inhibition of growth.

Of those pentacyclic triterpenes obtained from *A. populnea* tested, 20α-hydroxytingenone show high activity; epikatonic acid less active and populnilic acid and populnic acid were inactive against the trypanosome used. In addition the *T. (S.) cruzi* trypanosome from *P. hastatus* showed to be a good biological approach for *T. cruzi* screening of organic compounds.

RESUMO

Atividade anti-tripanosomíca de triterpenos pentacíclicos isolados de *Austroplenckia populnea* (Celastraceae)

Foram testados quatro triterpenos pentacíclicos isolados de *Austroplenckia populnea* e quatro compostos de conhecida atividade anti-*T. cruzi* ou anti-malária. Dos triterpenos testados 20α-hidroxi-tingenona mostrou atividade elevada, ácido epicatônico foi menos ativo, enquanto ácido populnilíco e populníco foram inativos contra o tripanossoma do subgênero *Schizotrypanum* testado. Benzimidazole, nifurtimox, cetoconazole e primaquina apresentaram efeito inibitório dose-dependente atingindo praticamente a inibição total do crescimento do parasita no final do tempo de incubação. O tripanossoma testado

mostrou ser um modelo adequado para uma seleção preliminar de compostos anti-*T. (S.) cruzi*.

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REFERENCES

- BRENER, Z. - Present status of chemotherapy and chemoprophylaxis of human trypanosomiasis in the western hemisphere. *Pharmacol. Therap.*, 7: 71-90, 1979.
- CORREA, M.P. - *Dicionário das plantas úteis do Brasil*. Rio de Janeiro, Ministério da Agricultura, 1969. p. 152.
- GABORAK, M.; DARLING, J.L. & GUTTERIDGE, W.E. - Comparative drug sensitivities of culture forms of *Trypanosoma cruzi* and *Trypanosoma dionisii*. *Nature (Lond.)*, 268: 339-340, 1977.

4. GLOBE, F.C. - Activity of certain 6-Methoxy-8-aminoquinolines against *Trypanosoma cruzi*. **Antibiot. and Chemother.**, **41**: 265-270, 1985.
5. GOIJMAN, S.G.; TURRENS, J.F.; MARINI-BETTOLO, G.B. & STOPPANI, A.O.M. - Effect of tingenone, a quinonoid triterpene, on growth and macromolecule biosynthesis on *Trypanosoma cruzi*. **Experientia (Basel)**, **41**: 646-648, 1985.
6. GONZALEZ, J.G.; DELLE MONACHE, G.; DELLE MONACHE, F. & MARINI-BETTOLO, G.B. - Chuchuhuasha: a drug used in folk medicine in the Amazonian and Andean areas. A chemical study of *Maytenus laevis*. **J. Ethnopharm.**, **5**: 73-77, 1982.
7. HOARE, C.A. - **The trypanosomes of mammals: a zoological monography**. Oxford, Blackwell, 1972.
8. MONACHE, F.D. - Populnic acid, a new triterpenic acid with friedelane carbon skeleton. **Gazz. Chim. ital.**, **102**: 636-645, 1972.
9. PINTO, A.S.; RENAULT, C.P.; TAFURI, W.S. & CHIARI, E. - *Trypanosoma cruzi*-like trypanosomes isolated from the bat *Phyllostomus hastatus*. **Mem. Inst. Oswaldo Cruz**, **82**(supl.): 53, 1987.
10. PINTO, A.S.; TEIXEIRA, L.F.M.; SOUTO-PADRON, T. & ANDRADE, A.F.B. - Cell surface analysis of trypanosomes of the sub-genus *Schizotrypanum* isolated from bat. **Parasitology**, **3**: 141-146, 1995.
11. RAO, K.S. - Antibacterial activity of some medicinal plants of Papua New Guinea. **Int. J. Pharmacognosy**, **34**: 223-225, 1996.
12. SOUSA, J.R.; JANNOTTI, N.K.; SILVA, G.D.F. & PINHEIRO, J.A. - Friedelane triterpene related to populnic acid. **Gazz. Chim. ital.**, **118**: 821-822, 1988.
13. SOUSA, J.R.; SILVA, G.D.F.; PERDESOLI, J.L. & ALVES, R.J. - Friedelane and oleanane triterpenoids from bark wood of *Austroplenckia populnea*. **Phytochemistry**, **29**: 3259-3261, 1990.
14. TAYLOR, E.R.R. - Bureau of hygiene and tropical diseases, trypanosomiasis. **Trop. Dis. Bull.**, **8**: 3, 1986.
15. TEIXEIRA, L.F.M.; GONÇALVES, A.M.; ROMANHA, A.J.; STEINDEL, M. & PINTO, A.S. - Schizodeme and zymodeme analysis of trypanosomes of the subgenus *Schizotrypanum* from the bat. **Parasit. Res.**, **79**: 497-500, 1993.
16. VIEIRA FILHO, S.A.; DUARTE, L.P.; PAES, H.C.S. *et al.* - Antibacterial activity of pentacyclic triterpenes from *Austroplenckia populnea*. **Acta Horticulturae**, **501**: 199-203, 1999.
17. WORLD HEALTH ORGANIZATION - Control of Chagas disease. Report of a WHO Expert Committee. **Wld. Hlth. Org. techn. Rep. Ser.**, (811): 27-31, 1991.

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