# Anti-human immunodeficiency virus activity of some tropical medicinal plants

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## Abstract

Eighty-two extracts of plant materials medicinally used in Panama and Sri Lanka were tested for their inhibitory effects on HIV-1 replication. In the assay of HIV-1-infected human T-cell line, water extracts of *Pogostemon heynaenus* (leaves) and *Jatropha curcas* (branches) inhibited the HIV-1-induced cytopathic effect with $IC_{50}$ of 20.8 and 24.0 $\mu$g/ml, respectively with a considerable selectivity index (> 48.1 and >41.7). Furthermore they also suppressed the formation of syncytia in co-cultures of HIV-1-infected and -uninfected T-cell lines at nontoxic concentrations.

**Key words** Anti-HIV-1 activity, Panamanian plants, Ayurvedic medicines.

**Abbreviations** CC, cytotoxic concentration ; $CC_{50}$, 50 % cell toxicity concentration ; CPE, cytopathic effect ; IC, inhibitory concentration ; $IC_{50}$, 50 % inhibitory concentration ; HIV-1, human immunodeficiency virus - type 1 ; mCDS71, modified cyclodextrin sulfate ; SI, selectivity index ; $TCID_{50}$, 50 %-tissue culture infective dose.

## Introduction

Human immunodeficiency virus (HIV) has been considered to be the etiological agent of acquired immunodeficiency syndrome (AIDS). It is known to be a retrovirus that infects T-cells through binding to CD4 protein, a receptor present on the surface of the cell, where it eventually replicates inducing immunodeficiency. A few numbers of drugs, such as azidothymidine, dideoxycytidine and dideoxyinosine, have been approved for the treatment of AIDS but several herbal medicines have been also taken by AIDS patients althougt there was no scientific evidence about their efficacy.[1] Therefore the elucidation on the pharmacological effects of such alternative therapies are urged along with the investigations for discovery of new drugs. A rational method for this kind of investigation has been the study of medicinal plants that have important bioactive constituents to be explored.

During the course of our studies on development of anti-HIV agents from natural sources, we screened various tropical plants used as crude drugs in Panama and Sri Lanka for their anti-HIV activity in human T-cell lines, MT-4 and MOLT-4 cells. As the results show, some extracts showed significant inhibitory effects on HIV replication and were found to be candidates for further study on the active principles.

## Materials and Methods

*Plant materials* : Plant materials **1** to **70** were collected in the Republic of Panama and identified by

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Mireya Correa, Director of the Herbarium of the University of Panama and Smithsonian Tropical Research Institute, and Carmen Galdames, Botanical Assistant of CIFLORPAN, Panama. Materials **71** to **82** were purchased from W. Wilbert and Co. (Colombo, Sri Lanka) and their botanical sources were identified by Upali Pilapitiya, Institute of Bandaranayake Memorial Ayurvedic Medicine, Sri Lanka. Panamanian voucher specimens are deposited in the Herbarium of the University of Panama and those from Sri Lanka are stored in the Herbarium of Materia Medica of Toyama Medical and Pharmaceutical University.

*Preparation of plant extracts* : Five grams of each plant material were extracted three times with 100 ml of distilled water or methanol, under reflux for 3h. The extracts were then filtered and dried *in vacuo*. For tests in cell culture, the water extracts were dissolved in culture medium and the methanol extracts were dissolved in methanol before adding to the medium. The final concentration of methanol did not exceed 2 %.

*Cell* : The HTLV-1-infected cell line MT-4 and human leukemia T-cell line MOLT-4 were maintained at 37°C under 5 % $CO_2$ in RPMI-1640 medium (Flow Laboratories, Irvine, Scotland) supplemented with 10 % fetal calf serum (FCS, Flow Laboratories, North Ryde, Australia), 100 $\mu$g/ml of streptomycin (Meiji Seika, Tokyo, Japan) and 100 U/ml of penicillin G (Banyu Pharmaceutical, Tokyo, Japan).

*Virus* : HIV-1 (strain HTLV-$III_B$) was obtained from the supernatant of MOLT-4/HTLV-$III_B$ cells.

*Primary screening for anti-HIV-1 activity* : MT-4 cells were infected for 1 h with HIV-1 (HTLV-$III_B$) at 50 %-tissue culture infective dose ($TCID_{50}$) of 0.001/cell. Then, the cells were resuspended at $1\times10^5$ cells/ml in RPMI-1640 medium and 200 $\mu$l/well of the cell suspension was cultured for 5 days in a 96-well culture plate containing various concentrations (12 doses, maximum 1860-850 $\mu$g/ml and minimum 0.89-0.42 $\mu$g/ml) of the plant extracts. Control assays were performed in the absence of plant extract with HIV-1-infected and -uninfected cultures. On day 5, the inhibitory concentration (IC) of the test sample required to prevent HIV-1-induced cytopathic effect completely[2] was examined through an optical microscope and the cell growth was visualized to give a cytotoxic concentration (CC) that reduces the viability of MT-4 cells. Modified cyclodextrin sulfate (mCDS71) was used as an HIV-1 inhibitory control,[3] whose IC and CC values were $\geq$0.98 and $>$1000 $\mu$g/ml, respectively.

*Inhibition of HIV-1 induced cytopathic effect (CPE) on MT-4 cells* : On the primary screening test, 12 plant extracts were found to inhibit HIV-1 induced CPE and then they were investigated by an accurate method as follows. The assay was carried out in a 48-well culture plate (600 $\mu$l/well) for 5 days by the same method used for the primary screening. After incubation the CPE was observed and the number of viable cells was counted by the trypan blue exclusion method. The score of viable cells in HIV-1-infected MT-4 cell test exhibited the amount of plant extract required to inhibit HIV-1 replication by 50 % ($IC_{50}$), and in uninfected MT-4 cell culture, the dose that reduced the viability of uninfected cells by 50 % ($CC_{50}$) was observed. The ratio of $IC_{50}/CC_{50}$ was calculated as a selectivity index (SI).

*Suppression on giant cell formation* : The 12 plant extracts were also investigated on the suppressive effect of giant cell formation in a co-culture of HIV-1 infected and -uninfected MOLT-4 cells.[4] MOLT-4 and MOLT-4/HTLV-$III_B$ cells were mixed in a proportion of 1 : 1 (total cell number of $5\times10^5$ cells/ml, 600 $\mu$l/well) and cultured for 20 h in the presence of various concentrations of plant extracts. After that, the formation of giant cell was examined in the optical microscope and results were given by doses that suppress the formation of syncytia and that reduce the viability of MOLT-4 cells.

## Results

*Primary screening on anti-HIV-1 activity*

The plant extracts were first investigated for their effects on viral replication. In the primary test, HIV-1 induced CPE was inhibited by 12 extracts, which showed IC values lower than the respective CC values (Table I). These extracts are the water extracts of the aerial part of *Baccharis trinervis* (**11**, IC : 62.5 $\mu$g/ml), the aerial part of *Bidens pilosa* (**13**, IC : 250 $\mu$g/ml), the roots of *Calea jamaicensis* (**16**, IC :

125 μg/ml), the leaves of *Cordia spinescens* (**21**, IC : 31.2 μg/ml), the trunk of *Cornutia grandifolia* (**23**, IC : 125 μg/ml), the trunk of *Croton billbergianus* (**24**, IC : 1000 μg/ml), the leaves of *Drymonia serrulata* (**25**, IC : 250 μg/ml), the branches of *Jatropha curcas* (**41**, IC : 125 μg/ml), and the leaves of *Pogostemon heynaenus* (**78**, IC : 62.5 μg/ml). The methanol extracts that showed the inhibitory effects were of the leaves of *Acalypha macrostachya* (**4**, IC : 125 μg/ml) and *Jatropha curcas* (**44**, IC : 31.2 μg/ml), and of the whole plant of *Pereskia bleo* (**57**, IC : 250 μg/ml). The CC values of the above extracts ranged from 62.5 to >1000 μg/ml.

*Inhibition of HIV-1 induced CPE on MT-4 cells*

The above 12 extracts showing significant anti-HIV activity in primary screening were submitted to a more accurate test for inhibition of CPE. $IC_{50}$ and $CC_{50}$ values of each sample were observed in a 5-day culture (Table II). $IC_{50}$ ranged from 9.0 to 630 μg/ml and $CC_{50}$, from 52 to >1000 μg/ml. Appreciable SI values were given by the water extracts of the branches of *Jatropha curcas* (**41**) and the leaves of *Pogostemon heynaenus* (**78**), whose SI were >41.7 and >48.1, respectively.

*Suppressive effect on giant cell formation*

All of the 12 extracts were tested for suppressing the formation of giant cell in co-cultures of HIV-1-infected and -uninfected MOLT-4 cells (Table III). The most potent inhibitory effect on giant cell formation was found in the water extract of the leaves of *Cordia spinescens* (**21**, 62.5 μg/ml). Other extracts including those with considerable SI values on CPE of MT-4 cells showed moderate suppression with IC of 125-500 μg/ml or were inactive.

Table I Anti-HIV-1 activity of the plant extracts.

| Botanical name | Family | Part used | Extract | IC (μg/ml) | CC (μg/ml) |
|---|---|---|---|---|---|
| **1** *Acalypha macrostachya* JACQ. | Euphorbiaceae | Branch | Water | NE | ≥250 |
| **2** *A. macrostachya* JACQ. | Euphorbiaceae | Branch | Methanol | NE | ≥500 |
| **3** *A. macrostachya* JACQ. | Euphorbiaceae | Leaf | Water | NE | ≥500 |
| **4** *A. macrostachya* JACQ. | Euphorbiaceae | Leaf | Methanol | 125 | ≥250 |
| **5** *Aegiphila anomala* PITT. | Verbenaceae | Leaf | Water | NE | 62.5 |
| **6** *Aphelandra sinclairiana* NEES in BENTH. | Acanthaceae | Branch | Water | NE | ≥250 |
| **7** *A. sinclairiana* NEES in BENTH. | Acanthaceae | Branch | Methanol | NE | ≥250 |
| **8** *A. sinclairiana* NEES in BENTH. | Acanthaceae | Leaf | Water | NE | ≥500 |
| **9** *A. sinclairiana* NEES in BENTH. | Acanthaceae | Leaf | Methanol | NE | ≥250 |
| **10** *Baccharis pedunculata* (MILL.) CABR. | Compositae | Aerial part | Water | NE | 125 |
| **11** *Baccharis trinervis* (LAM.) PERS. | Compositae | Aerial part | Water | 62.5 | 250 |
| **12** *Begonia glabra* AUBL. | Begoniaceae | whole plant | Water | NE | 250 |
| **13** *Bidens pilosa* L. | Compositae | Aerial part | Water | 250 | 500 |
| **14** *Bursera simaruba* (L.) SARG. | Burseraceae | Trunk | Methanol | NE | 62.5 |
| **15** *Calea jamaicensis* (L.) L. | Compositae | Branch | Water | NE | 15.6 |
| **16** *C. jamaicensis* (L.) L. | Compositae | Root | Water | 125 | 250 |
| **17** *C. jamaicensis* (L.) L. | Compositae | Root | Methanol | NE | 250 |
| **18** *Chamaesyce hyssopifolia* (L.) SMALL | Euphorbiaceae | Whole plant | Water | NE | ≥31.2 |
| **19** *C. hyssopifolia* (L.) SMALL | Euphorbiaceae | Whole plant | Methanol | NE | ≥62.5 |
| **20** *Commelina diffusa* BURM. f. | Commelinaceae | Whole plant | Water | NE | 1000 |
| **21** *Cordia spinescens* L. | Boraginaceae | Leaf | Water | 31.2 | 62.5 |
| **22** *C. spinescens* L. | Boraginaceae | Leaf | Methanol | NE | 62.5 |
| **23** *Cornutia grandifolia* (SCHLECHT. & CHAM.) SCHAU. in DC | Verbenaceae | Trunk | Water | 125 | 250 |
| 24 *Croton billbergianus* MUELL.- ARG. | Euphorbiaceae | Trunk | Water | 1000 | >1000 |
| **25** *Drymonia serrulata* (JACQ.) MART. | Gesneriaceae | Leaf | Water | 250 | 1000 |
| **26** *Erythroxylum citrifolium* ST. HIL. | Erythroxylaceae | Trunk | Methanol | NE | 31.2 |
| **27** *E. lucidum* H. B. K. | Erythroxylaceae | Leaf | Methanol | NE | 62.5 |
| **28** *Faramea eurycarpa* J. D. SM. | Rubiaceae | Leaf | Water | NE | 31.2 |
| **29** *F. eurycarpa* J. D. SM. | Rubiaceae | Root | Water | NE | 31.2 |
| **30** *Guazuma ulmifolia* LAM. | Sterculiaceae | Leaf | Water | NE | ≥250 |
| **31** *G. ulmifolia* LAM. | Sterculiaceae | Leaf | Methanol | NE | ≥125 |
| **32** *Hamelia axillaris* SWARTZ | Rubiaceae | Branch | Water | NE | ≥250 |
| **33** *H. axillaris* SWARTZS | Rubiaceae | Branch | Methanol | NE | ≥125 |

Table I, continued

| | Botanical name | Family | Part used | Extract | IC($\mu$g/ml) | CC($\mu$g/ml) |
|---|---|---|---|---|---|---|
| 34 | *Hamelia axillaris* SWARTZ | Rubiaceae | Leaf | Water | NE | ≥62.5 |
| 35 | *H. axillaris* SWARTZ | Rubiaceae | Leaf | Methanol | NE | ≥31.2 |
| 36 | *Hoffmannia woodsonii* STANDL. | Rubiaceae | Leaf | Methanol | NE | 500 |
| 37 | *Hyptis brevipes* POIT. | Labiatae | Aerial part | Water | NE | 250 |
| 38 | *H. capitata* JACQ. | Labiatae | Aerial part | Methanol | NE | 250 |
| 39 | *H. lantanaefolia* POIT. | Labiatae | Aerial part | Water | NE | 31.2 |
| 40 | *H. obtusiflora* PRESL & ex BENTE | Labiatae | Aerial part | Methanol | NE | 125 |
| 41 | *Jatropha curcas* L. | Euphorbiaceae | Branch | Water | 125 | ≥1000 |
| 42 | *J. curcas* L. | Euphorbiaceae | Branch | Methanol | NE | ≥62.5 |
| 43 | *J. curcas* L. | Euphorbiaceae | Leaf | Water | (250) | ≥250 |
| 44 | *J. curcas* L. | Euphorbiaceae | Leaf | Methanol | 31.2 | ≥125 |
| 45 | *Lindackeria laurina* PRESL. | Flacourtiaceae | Leaf | Water | NE | 62.5 |
| 46 | *L. laurina* PRESL. | Flacourtiaceae | Leaf | Methanol | NE | 62.5 |
| 47 | *Mikania banisteriae* DC. | Compositae | Branch | Water | NE | ≥125 |
| 48 | *M. banisteriae* DC. | Compositae | Branch | Methanol | NE | ≥250 |
| 49 | *M. banisteriae* DC. | Compositae | Leaf | Water | NE | ≥62.5 |
| 50 | *M. banisteriae* DC. | Compositae | Leaf | Methanol | NE | ≥62.5 |
| 51 | *Pavonia schiedeana* STEUD. | Malvaceae | Aerial part | Methanol | NE | 125 |
| 52 | *Peltastes colombianus* WOODS. | Apocynaceae | Branch | Water | NE | ≥125 |
| 53 | *P. colombianus* WOODS. | Apocynaceae | Branch | Methanol | (500) | ≥500 |
| 54 | *P. colombianus* WOODS. | Apocynaceae | Leaf, flower | Water | NE | ≥250 |
| 55 | *P. colombianus* WOODS. | Apocynaceae | Leaf, flower | Methanol | NE | ≥250 |
| 56 | *Pereskia bleo* (H.B.K.) DC. | Cactaceae | Whole plant | Water | NE | >1000 |
| 57 | *P. bleo* (H.B.K.) DC. | Cactaceae | Whole plant | Methanol | 250 | 1000 |
| 58 | *Polygonum punctatum* ELL. | Polygonaceae | Root | Methanol | NE | 31.2 |
| 59 | *Psychotria camponutans* (DWYER & HAYDEN) HAMMEL | Rubiaceae | Aerial part | Methanol | NE | 250 |
| 60 | *Rauvolfia littoralis* RUSBY | Apocynaceae | Leaf, branch | Methanol | NE | 125 |
| 61 | *Ruellia biolleyi* LINDAU in PITT. | Acanthaceae | Whole plant | Methanol | NE | 500 |
| 62 | *Serjania mexicana* (L.) WILLD. | Sapindaceae | Whole plant | Water | (62.5) | ≥62.5 |
| 63 | *S. mexicana* (L.) WILLD. | Sapindaceae | Whole plant | Methanol | NE | ≥250 |
| 64 | *Tetrapteris macrocarpa* JOHNST. | Malpighiaceae | Aerial part | Methanol | NE | 125 |
| 65 | *Waltheria indica* L. | Sterculiaceae | Branch | Water | NE | ≥62.5 |
| 66 | *W. indica* L. | Sterculiaceae | Branch | Methanol | NE | ≥62.5 |
| 67 | *W. indica* L. | Sterculiaceae | Leaf | Water | NE | ≥31.2 |
| 68 | *W. indica* L. | Sterculiaceae | Leaf | Methanol | NE | ≥62.5 |
| 69 | *Xylopia frutescens* AUBL. | Annonaceae | Leaf | Methanol | NE | 31.2 |
| 70 | *X. frutescens* AUBL. | Annonaceae | Bark | Methanol | NE | 31.2 |
| 71 | *Areca catechu* L. | Palmae | Seed | Water | NE | ≥15.6 |
| 72 | *A. catechu* L. | Palmae | Seed | Methanol | NE | ≥31.2 |
| 73 | *Cassia fistula* L. | Leguminosae | Bark | Methanol | NE | ≥31.2 |
| 74 | *Coleus amboinicus* LOUR. | Labiatae | Leaf | Water | NE | ≥62.5 |
| 75 | *C. amboinicus* LOUR. | Labiatae | Leaf | Methanol | NE | ≥500 |
| 76 | *Ficus religiosa* L. | Moraceae | Bark | Water | (62.5) | ≥62.5 |
| 77 | *F. religiosa* L. | Moraceae | Bark | Methanol | NE | ≥15.6 |
| 78 | *Pogostemon heynaenus* BENTH. | Labiatae | Leaf | Water | 62.5 | ≥500 |
| 79 | *P. heynaenus* BENTH. | Labiatae | Leaf | Methanol | NE | ≥12.5 |
| 80 | *Punica granatum* L. | Punicaceae | Pericarp | Water | NE | ≥15.6 |
| 81 | *P. granatum* L. | Punicaceae | Pericarp | Methanol | NE | ≥15.6 |
| 82 | *Terminalia chebula* RETZ. | Combretaceae | Fruit | Methanol | NE | ≥15.6 |

IC, the minimum concentration for complete inhibition of HIV-1 induced CPE in MT-4 cells by microscopic observation.
CC, the minimum concentration for appearance of MT-4 cell toxicity by microscopic observation.
NE, not effective ; ( ), concentration at which anti-HIV-1 activity and cytotoxicity were observed.

Table II Inhibition of cytopathogenicity on HIV-1-infected MT-4 cells.

| | Material (part used, extract) | $IC_{50}$ ($\mu$g/ml) | $CC_{50}$ ($\mu$g/ml) | SI |
|---|---|---|---|---|
| **4** | *Acalypha macrostrachya* (leaf, MeOH) | >500 | 190 | − |
| **11** | *Baccharis trinervis* (aerial part, $H_2O$) | 38.0 | 260 | 6.84 |
| **13** | *Bidens pilosa* (aerial part, $H_2O$) | 54.0 | 420 | 7.78 |
| **16** | *Calea jamaicensis* (root, $H_2O$) | 62.0 | 140 | 2.26 |
| **21** | *Cordia spinescens* (leaf, $H_2O$) | 15.5 | 96.0 | 6.19 |
| **23** | *Cornutia grandifolia* (trunk, $H_2O$) | 55.0 | 250 | 4.55 |
| **24** | *Croton billbergianus* (trunk, $H_2O$) | 630 | >1000 | >1.59 |
| **25** | *Drymonia serrulata* (leaf, $H_2O$) | 130 | 1000 | 7.69 |
| **41** | *Jatropha curcas* (branch, $H_2O$) | 24.0 | >1000 | >41.7 |
| **44** | *J. curcas* (leaf, MeOH) | 9.0 | 52 | 5.8 |
| **57** | *Pereskia bleo* (whole plant, MeOH) | 100 | 94 | 0.94 |
| **78** | *Pogostemon heyneanus* (leaf, $H_2O$) | 20.8 | >1000 | >48.1 |
| | mCDS71 | 0.77 | 1000 | 1298.7 |

The data show the inhibition of cytopathogenicity on MT-4 cells. Cell viability was measured by the method of trypan blue. $IC_{50}$, 50 % inhibitory concentration ; $CC_{50}$, 50 % cell toxicity concentration ; SI, selectivity index ($CC_{50}/IC_{50}$).

Table III Suppression of giant cell formation.

| | Material (part used, extract) | IC($\mu$g/ml) | CC($\mu$g/ml) |
|---|---|---|---|
| **4** | *Acalypha macrostrachya* (leaf, MeOH) | >500 | ≥1000 |
| **11** | *Baccharis trinervis* (aerial part, $H_2O$) | 125 | >1000 |
| **13** | *Bidens pilosa* (aerial part, $H_2O$) | 500 | >1000 |
| **16** | Calea jamaicensis (root, $H_2O$) | 250 | >1000 |
| **21** | *Cordia spinescens* (leaf, $H_2O$) | 62.5 | >1000 |
| **23** | *Cornutia grandifolia* (trunk, $H_2O$) | 500 | >1000 |
| **24** | *Croton billbergianus* (trunk, $H_2O$) | NE | >1000 |
| **25** | *Drymonia serrulata* (leaf, $H_2O$) | 1000 | >1000 |
| **41** | *Jatropha curcas* (branch, $H_2O$) | 500 | >1000 |
| **44** | *J. curcas* (leaf, $H_2O$) | 500 | ≥500 |
| **57** | *Pereskia bleo* (whole plant, $H_2O$) | NE | ≥1000 |
| **78** | *Pogostemon heyneanus* (leaf, $H_2O$) | 500 | >1000 |
| | mCDS71 | 2.9 | >1000 |

IC, the minimum concentration in which the complete inhibition was observed by optical microscope.
NE, not effective.
CC, the minimum concentration in which cell toxicity was observed by optical microscope.

## Discussion

In the course of searching for naturally-occurring substances with anti-HIV activities, crude drugs used in traditional medicines such as Chinese or Jamu (Indonesia) have been tested for their inhibitory effects on the replication of HIV-1 and also on some specific viral enzymes, such as reverse transcriptase and protease.[5-7] The present study is a preliminary test of medicinal plants used in Panama and Sri Lanka for anti-HIV activity in cultured human T-cell lines. Of these, 12 extracts were found to inhibit the cytopathic effects induced by HIV-1 infection to MT-4 cells, at nontoxic concentrations for the cells. Although the effects of the extracts were not so potent as mCDS71, a synthetic compound used as the inhibitory control, the water extracts of the branches of *Jatropha curcas* (**41**) and the leaves of *Pogostemon heynaenus* (**78**) showed meaningful SI values.

On the other hand, some extracts, such as those of *Cordia spinescens* (**21**) and *Baccharis trinervis* (**11**) showed appreciable suppression in the formation of multinucleated giant cells or syncytia, which are formed by fusion of HIV-infected and uninfected cells through the binding of the respective gp120 glycoproteins and cell CD4 receptors. However, the inhibitory effects of most of the extracts were not so potent as the effects on HIV-1 induced CPE to the MT-4 cells. The giant cell formation seems to be an important process in the depletion of $CD4^+$ T-lymphocytes in HIV-infected persons[8] and inhibition of this process may also be a promising target for the development of new anti-HIV agents.

A few phytochemical studies have been carried out on the above plants. Some flavonoids were isolated from *Jatropha curcas*[9] and diterpenoids from *Baccharis trinervis*[10] and *Jatropha curcas*,[11] however, the role of these compounds in suppressing the replication of HIV-1 is not clear so far.

## 和文抄録

82種類のパナマおよびスリランカ生薬の抗HIV作用を *in vitro* で検討した結果，培養ヒトT-細胞(MT-4)におけるHIV-1の増殖を *Pogostemon heynaenus* (葉)及び *Jatropha curcas* (枝)の水エキスが強く阻害することを見いだした。それらの $IC_{50}$ はそれぞれ20.8，24.0 $\mu$g/mlで，かなり良い選択係数を示した。さらにこれらエキスは細胞毒性を示さない濃度範囲で，HIV-1持続感染及び非感染MOLT-4細胞間の巨細胞形成を抑制した。

## References

1) Memoranda, *In vitro* screening of traditional medicines for anti-

HIV activity : Memorandum from a WHO meeting. *Bulletin of the World Health Organization* **67**, 613-618, 1989.

2) Harada, S., Koyanagi, Y., and Yamamoto, N. : Infection of HTLV-III/LAV in HTLV-I-carrying cells MT-2 and MT-4 and application in a plaque assay. *Science* **229**, 563-566, 1985.

3) Moriya, T., Saito, K., Kurita, H., Matsumoto, K., Otake, T., Mori, H., Morimoto, M., Ueba, N., and Kunita, N.: A new candidate for an anti-HIV-1 agent : modified cyclodextrin sulfate (mCDS71). *J. Med. Chem.* **36**, 1674-1677, 1993.

4) Nakashima, H., Tochikura, T., Kobayashi, N., Matsuda, A., Ueda, T., and Yamamoto, N. : Effect of 3'-azido-2', 3' dideoxythymidine (AZT) and neutralizing antibody on human immunodeficiency virus (HIV) induced cytopathic effects : implication of giant cell formation for the spread of virus in vivo. *Virology* **159**, 169-173, 1987.

5) Chang, R. S., and Yeung, H. W. : Inhibition of growth of human immunodeficiency virus *in vitro* by crude extracts of Chinese medicinal herbs. *Antiviral Res.* **9**, 163-176, 1989.

6) Otake, T., Mori, H., Morimoto, M., Ueba, N., Sutardjo, S., Kusumoto, I.T., Hattori, M., and Namba, T. : Screening of Indonesian plant extracts for anti-human immunodeficiency virus-type 1 (HIV-1) activity. *Phytother. Res.* in press.

7) Kusumoto, I. T., Kakiuchi, N., Hattori, M., Sutardjo, S., Namba, T., and Shimotohno, K. : Screening of some Indonesian medicinal plants for inhibitory effects on HIV-1 protease. *Shoyakugaku Zasshi* **46**, 190 193, 1992.

8) Haseltine, W. B. : Replication and pathogenesis of AIDS virus. *J. Acq. Immun. Defic. Synd.* **1**, 217-240, 1988.

9) Naengchomnong, W., Thebtaranonth, Y., Wiriyachitra, P., Okamoto, K. T., and Clardy, J. : Isolation and structure determination of four novel diterpenes from *Jatropha curcas*. *Tetrahedron Lett.* **27**, 2439-2442, 1986.

10) Khafagy, S. M., Mohamed, Y. A., Salam, N. A. A., and Mahmoud, Z. F. ; Phytochemical studies of *Jatropha curcas*. *Planta Med.* **31**, 273-277, 1977.

11) Jakupovic, J., Eid, F., and King, R. M. : Further ingredients of *Baccharis trinervis*. *Pharmazie* **41**, 157-158, 1986. C.A. 105 : 75869k.