Antiviral activity of *Terminalia*

Hepatitis B Virus (HBV) is a causative agent of the most frequent viral infections of man. Since the non-human host range of HBV is restricted to a few animals, such as, chimpanzee, the development of new therapeutics for HBV has been hampered. Several cell lines were developed to identify potential therapeutics against HBV infection. One of these, the HepG2 2.2.15 cell line, was derived through transfection of a cloned HBV gene into a well-characterised human hepatoblastoma cell line HepG2, with which a standardized cell culture assay was established for potential anti-HBV active agents.

Recently it was reported that the aqueous extracts of four plants, *Terminalia chebula* Retz., *Sanguisorba officinalis* Linn., *Rubus coreanus* Miq. and *Rheum palmatum* Linn., exhibited more than 50% inhibition of HBV DNA polymerase activity in vitro and showed potential antiviral effects against duck hepatitis B virus. Kim and others from South Korea examined the four plant extracts for antiviral effects against human HBV using a cell culture system with HepG2 2.2.15 cells. The extracts were assayed for the inhibition of HBV multiplication by measurement of HBV DNA and surface antigen (HBsAg) levels in the extracellular medium of HepG2 2.2.15 cells after an 8-day treatment. All extracts decreased the levels of extracellular HBV virion DNA at concentrations ranging from 64 to 128 \( \mu g/ml \) and inhibited the secretion of HBsAg dose dependently. Of the four tested plants, *Terminalia chebula* exhibited the most prominent anti-HBV activities [Kim et al, Phytother Res, 2001, 15(8), 718-720].

Grape fruit to treat Alzheimer's disease

Inhibitors of cholinesterases are currently used as anticholinesterase in clinical trials for the examination on the treatment of Alzheimer's disease. Anticholinesterase may interact with central cholinergic system to improve memory and cognitive deficits of the patients by diminishing the breakdown of acetylcholine at the synaptic site in the brain.

In these cholinesterases, acetylcholinesterase (AChE) inhibitors have often been much used in the treatment of Alzheimer's disease. Some of these have been found naturally occurring in plants. Miyazawa and others from Japan studied the inhibition of AChE activity from grape fruit, *Citrus paradisi* Macf. oil.

Inhibition of AChE was measured by the colorimetric method. Nootkatone and auraptene were isolated from grape fruit essential oil and showed 17-24% of inhibition of AChE activity at the concentration of 1.62 \( \mu g/ml \). The fraction of oil, which contains 31.4% nootkatone, 52.2% auraptene and other minor compounds, showed stronger inhibition (54.2%) than compound nootkatone and auraptene [Miyazawa et al, Nat Prod Lett, 2001, 15(3), 205-210].

**Antimalarial and anticancer activity of Perovskia**

*Perovskia abrotanoides* Kar. is a herb used to treat leishmaniasis in Iranian folk-medicine. Villagers apply a poultice, made of crushed roots of the plant, water, sesame oil, and wax, on lesions by cutaneous leishmaniasis. Sairafianpour and others isolated diterpenoid quinones from this plant and studied their leishmanicidal, antiplasmoidal and cytotoxic activity.

Cryptotanshinone, 1β-hydroxycryptotanshinone, 1-oxocryptotanshinone and 1-oxomiltirone are isolated from roots of this plant. The compounds exhibited leishmanicidal activity in vitro (IC\(_{50}\) value in the range 18-47 \( \mu M \)). These findings provide a rationale for traditional use of the roots in Iran as a constituent of poultices for treatment of cutaneous leishmaniasis. The isolated tanshinones also inhibited growth of cultured malaria parasites (3D7 stain of *Plasmodium falciparum*), drug-sensitive KB-3-1 human carcinoma cell line, multidrug-resistant KB-V1 cell line, and human lymphocytes activated with phytohaemagglutinin A (IC\(_{50}\) values in the range 5-45 \( \mu M \)) [Sairafianpour et al, J Nat Prod, 2001, 64(11), 1398-1403].
Radioprotective properties of *Triphala*

The search for radioprotectors started with the realization of the need for a safeguard against the military use of atomic weapons. Sulfhydryl compounds showed superior radioprotection but they are toxic at the optimum protective dose. *Triphala* is one of the important *rasayana* drugs commonly used in the Ayurvedic System of Medicine. This is an antioxidant rich herbal formulation that has been reported to treat anemia, jaundice, constipation, cough, asthma, fever, eye diseases, chronic ulcers, leucorrhoea, pyorrhea and also assists in weight loss. Jagetia and others from Kasturba Medical College, Manipal studied radioprotective property of *Triphala*.

*Triphala* is a mixture of fruits of three plants namely *Terminalia chebula* Retz., *Terminalia bellirica* (Gaertn.) Roxb. and *Phyllanthus emblica* Linn. (Emblica officinalis Gaertn.) in powdered form in equal proportions. The effect of 0, 5, 6.25, 10, 12.5, 20, 25, 40, 50 and 80 mg/kg body wt of aqueous extract of *Triphala* administered intraperitoneally was studied on the radiation-induced mortality in mice exposed to 10 Gy of γ-radiation. Treatment of mice with different doses of *Triphala* consecutively for five days before irradiation delayed the onset of mortality and reduced the symptoms of radiation sickness when compared with the non-drug treated irradiated controls. The highest protection against GI (gastrointestinal) death was observed for 12.5 mg/kg *Triphala*, where a highest number of survivors were reported up to 10 days post-irradiation. While 10 mg/kg *Triphala* i.p. provided the best protection as evidenced by the highest number of survivors after 30 days post-irradiation in this group when compared with other doses of *Triphala*.

Toxicity study showed that *Triphala* was non-toxic up to a dose of 240 mg/day, where no drug-induced mortality was observed. The LD$_{50}$ dose of i.p. of *Triphala* was found to be 280 mg/kg body weight. The study demonstrates the ability of *Triphala* as a good radioprotective agent and the optimum protective dose of *Triphala* was 1/28 of its LD$_{50}$ dose [Jagetia et al, *Phytomedicine*, 2002, 9(2), 99-108].

Antivirus activity of *Pachyrhizus seeds*

The pulverized seeds of *Pachyrhizus erosus* (Linn.) Urban are used as piscicides and pesticides. Preliminary examination using plaque reduction assay showed that the chloroform extract of the seeds showed potent activity against herpes simplex virus (HSV) types 1 and 2. The compounds rotenone and 12α-hydroxyrotenone exhibited cytotoxic activities against various tumour cell lines including human cancer cells. Phrutivorapongkul and others isolated the chemical compounds from the seeds of this plant and studied their activities against HSV.

From the seed of this plant they isolated rotenone (1), 12α-hydroxyrotenone (2), dolineone (3), neotenone (4), pachyrhizone (5), pachyrhizine (6), 12α-hydroxydolineone (7), dehydroneotenone (8), and 12α-hydroxydolineone (9). The activity of isolated compounds was studied using plaque reduction assay method. The two rotenoids, 7 and 9 showed moderate activity against HSV types 1 and 2 [Phrutivorapongkul et al, *Chem Pharm Bull*, 2002, 50, 534-537].

Spasmolytic activity of *Toddalia*

The root bark of the plant *Toddalia asiatica* (Linn.) Lamk var. *floribunda* is stomachic, antipyretic, antiperiodic and used as a tonic. The leaves and fruits are used for relieving stomach pain and dyspepsia. The roots are also used for the treatment of cough and influenza and an alcohol extract of both roots and leaves has been used as an antibacterial. The unripe fruits and roots are rubbed with oil to prepare a stimulant ointment for use in rheumatism. Lakshmi and others from Central Drug Research Institute, Lucknow evaluated the spasmolytic activity of the aerial parts of this plant. The ethanol extract exhibited significant spasmolytic activity and on further fractionation of extract was found concentrated only in the hexane and chloroform fractions [Lakshmi et al, *Phytother Res*, 2002, 16(3), 281-82].
Cytotoxic activity of amooranin

Aphanamixis polystachya (Wall.) Parker syn. Amoora rohituka Wight & Arn. is a medicinal plant and the stem bark is said to be a useful remedy for enlarged spleen, liver diseases, tumours and abdominal complaints. A preparation used for the treatment of cancer by the Ayurvedic System of Medicine contains the stem bark of Amoora rohituka, the fruit of Semicarpus anacardium and the root of Glycyrrhiza glabra. The extract of Amoora rohituka stem bark exerts cytotoxicity against MCF-7 cells and Dalton's lymphoma ascites cells. A triterpenoid, amooranin isolated from the stem bark of this plant has been found to be active against N-nitrosomethyl urea induced mammary adenocarcinoma in Sprague-Dawley rats.

Rabi and others from Thiruvananthapuram studied the in vitro cytotoxic activity of amooranin and its derivatives in various cell lines derived from tumour tissues or normal human tissue and in vivo antitumour activity against Ehrlich ascites cells. Amooranin and its methyl ester showed greater cytotoxicity against MCF-7 and HeLa cells derived from tumour tissues with a 50% inhibitory concentration (IC\textsubscript{50}) of 1.8-3.4 \(\mu\)g/ml, compared with Chang liver cells from normal tissue with an IC\textsubscript{50} of 6.2-6.4 \(\mu\)g/ml, but amooranin exhibited no activity on HEP-2 and L-929 cells. Of the cytotoxic isolates, the methyl ester derivative was inactive in in vivo evaluations in the Ehrlich ascites tumour cells at 50 and 100 mg/kg/day, demonstrating T/C values of 106% and 114%, respectively [Rabi et al, Phytother Res, 2002, 16 (suppl), S84-S86].

Antitumour effect of Tea

Tea, Camellia sinensis (Linn.) Kuntze is one of the most frequently consumed beverages. About 20% of the world production is consumed as green tea, an extract from dried tea leaves, whereas 80% is consumed as black tea, which is produced from the leaves by enzymatic oxidation. Recent reports on tea and human health claim a plethora of therapeutic properties including antilipidaemic, antineoplastic, antidiabetic, antihypertensive, antioxidant and many others. Experimental research has been conducted on the anticarcinogenic properties of mostly green tea extracts and its major constituents. Das and others from Indian Institute of Chemical Biology, Kolkata studied the antiinflammatory activity and antineoplastic effect of both black and green tea extract on solid tumour induced by 3-methylcholanthrene in mice.

Both black and green tea inhibited tumour growth and prevented metastasis. Histopathological study showed that tea treatment was able to reduce malignancy. Superoxide dismutase, a free radical scavenger, was found to be significantly increased in the serum of mice administered tea. Moreover, tea extracts were able to reduce the level of thiobarbituric acid reactive substance in the sera of mice. Tea extracts (both black and green) also showed anti-inflammatory activity in the carrageenan induced paw oedema model in the rat [Das et al, Phytother Res, 2002, 16(Suppl), S40-S44].

Anticancer alkaloids from Houttuynia cordata Thunb. is a traditional medicinal plant in Korea, Japan, India and China, and is used as a anti-pyretic, detoxicant, anti-ulcer remedy and as an anti-inflammatory agent. It is also used for promoting pus drainage and for insect bites. Kim and others from South Korea isolated six bioactive alkaloids, aristolactam B, piperolactam A, aristolactam A, norcephadione B, cepharadione B and splendidine from aerial parts of this plant. All the isolates exhibited moderate cytotoxicity against the five human cancer cell lines (A-549, SK-OV-3, SK-MEL-2, XF-498 and HCT-15) examined in vitro. Among them splendidine exhibited significant activity against each cell line and aristolactam B exhibited selective activity against XF-498 (central nervous system cell) (ED\textsubscript{50} 0.84 \(\mu\)g/ml) [Kim et al, Arch Pharm Res, 2001, 24(6), 518-521].
Antihypertensive activity of the alkaloids from drumstick leaves

The leaves of drumstick tree, *Moringa oleifera* Lam. have aphrodisiac properties and are used as an antihelmintic, treatment for hallucinations, dry tumours and asthma. A decoction of the fresh leaves is used as a gargle in the inflammation of the vocal cords. The leaf juice mixed with black pepper is used to treat headaches. The alcoholic extract of the leaves has been found to cause a gradual fall in the blood pressure of mongrel dogs and cats. The leaves have been found to be protective agents against cancer. The methanol fraction of the leaf extract has been found to have protective action against lesions in experimental rats.

Dangi and others from Mumbai examined the effect of the total alkaloids from the leaves of this plant on the isolated frog heart. The alkaloids obtained by the fractionation of the water extract of the leaves, converted into their salt form, were tested for their activity. The alkaloid salts were found to inhibit the response of the isolated frog heart on calcium. This suggested that the salts could have a calcium-channel blocking or a calcium-channel antagonising effect. Studies carried out on the guinea pig taenia coli, also demonstrated that the total alkaloidal salts of leaves have a calcium-channel blocking activity [Dangi et al, Pharm Biol, 2002, 20(2), 144-48].

Antioxidant activity of *Emblica*

The fruits of *Emblica officinalis* Gaertn. are used in Ayurveda as potent *rasayanas*, a class of plant-derived drugs reputed to promote health and longevity by increasing defence against disease, arresting the aging process, and revitalizing the body in debilitated conditions. Low molecular weight hydrolyzable gallotannins (EOT) comprising emblicin A, emblicin B, punigluconin and pedunculagin, isolated from the fresh juice of fruits, were shown to have significant antioxidant effects *in vitro* and *in vivo*. EOT was shown to exert antioxidant effects against iron-over-load hepatotoxicity and to elevate rat frontal cortical and striatal concentrations of superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPX), and reduce lipid peroxidation in these brain areas. EOT also prevented the adverse effects of chronic foot-shock-induced stress on SOD, CAT, GPX and lipid peroxidation in these brain areas.

Oxygen-derived free radicals play an important role in the initiation and progress of all clinically manifested aspects of ischemic heart disease. Myocardial cellular injury occurring during reperfusion of the ischemic cells, known as ischemia-reperfusion, is due primarily to oxidative stress. A number of studies have shown that antioxidants exert a protective effect against cardiac ischemia-reperfusion injury (IRI). Bhattacharya and others investigated the antioxidant effect of EOT is a rat model of cardiac IRI.

An emblicanin-A (37%) and B (33%) enriched fraction of fresh juice of Emblica fruits was investigated for antioxidant activity against ischemia-reperfusion (IRI)-induced oxidative stress in rat heart. Vitamin E (VE) was used as the standard antioxidant agent. IRI induced a significant decrease in the activities of cardiac superoxide dismutase, catalase and glutathione peroxidase, with a concomitant increase in lipid peroxidation. These IRI-induced effects were prevented by the administration of EOT (50 and 100 mg/kg body wt) and VE (200 mg/kg body wt) given orally thrice daily for 14 days prior to the sacrifice of the animals and initiation of the perfusion experiments. The study confirms the antioxidant effect of *Emblica officinalis* and indicates that the fruits of the plant may have cardioprotective effect [Bhattacharya et al, Phytomedicine, 2002, 9(2) 171-74].
The leaves and flowers of the traditional medicine *Trichodesma indicum* R. Br. are used as emollient and diuretic. The roots are used in dysentery, cough, cold, fever and joint pain. Srikanth and others evaluated the anti-tussive potential of methanol extract of whole plant on sulphurdioxide-induced cough reflex in mice to substantiate the folklore claim. The extract has demonstrated significant inhibition in frequency of cough in all the tested doses when compared with untreated control group. The effect persisted up to 90 min of its oral administration and also comparable to that exhibited by the standard drug (codeine phosphate). This study confirmed the traditional use of this plant in the treatment of cough [Srikanth et al, *Phytomedicine*, 2002, 9(1), 75-77].

According to the Sri Lankan Ayurvedic pharmacopoeia different parts of the plant, *Terminalia catappa* Linn. are recommended for diseases such as diarrhoea, gonorrhoea and several skin ailments including scabies. According to Sri Lankan folklore, the juice of tender leaves of this plant is recommended for severe pains including headaches.

Ratnasooriya and others from University of Colombo, Sri Lanka investigated the analgesic, anti-hyperalgesic and anti-inflammatory potential of the fresh juice of tender leaves of this plant. Tender leaves were macerated in a mortar to obtain juice/extract (40% v/w; 2.5 g of leaves produced 1 ml extract). Different doses of the extract (5, 10 or 15 ml/kg) or water were orally administered to male rats and the 10 ml/kg dose to female rats of different stages of estrous cycle and 1, 3 and 5 hr later, analgesic potential was determined. Different sets of rats were orally treated with 10 ml/kg of extract and these rats were subjected to carrageenan induced paw oedema, inflammatory and formalin induced pain tests. It was observed that the leaf extract possesses marked analgesic activity without any antihyperalgesic or anti-inflammatory activity [Ratnasooriya et al, *Pharm Biol*, 2002, 40(1), 60-66].
The plant, *Duranta repens* Linn. finds various medical uses in the indigenous system of medicine. The fruits of this plant afford a medicine for the treatment of malaria. The methanolic extract shows insecticidal and antifeedant properties. Preliminary pharmacological screening of the methanolic extract revealed inhibitory activity against both thrombin and prolyl endopeptidase (PEP) enzymes.

Prolyl endopeptidase plays an important role in the biological regulation of peptide hormones such as vasopressin, oxytocin, substance P, angiotensin and others. Alterations of PEP enzyme level and activity seems to be associated with several health disorders such as Alzheimers disease, depression, mania, thrombosis, AIDS and cancer. Specific inhibitors of PEP are expected to have anti-amnesic effects. Many PEP inhibitors have been synthesized as candidates for the treatment of neuropathological disorders. Anis and others from Pakistan isolated the flavonoids from this plant and studied their enzyme inhibitory activity.

From the whole plant they isolated 5,7-dihydroxy-3’-(2-hydroxy-3-methyl-3-butenyl)-3,6,4’-trimethoxy flavone (1), 3,7-dihydroxy-3’-(2-hydroxy-3-methyl-3-butenyl)-5,6,4’-trimethoxy flavone (2), 2,4’-dimethoxy-3’-(2-hydroxy-3-methyl-3-butenyl) acetophenone (3), 5-hydroxy-3,6,7,4’-tetramethoxy flavone (4), rosenolactone (5), 6,7-dimethoxy coumarin (6), 5α, 8α-epidioxyergosta-6,22-dien-3β-ol (7), and 5α, 8α-epidioxyergosta-6,9(11), 22-trien-3β-ol (8). The compounds (1-5) obtained from *Duranta repens* showed IC₅₀ values in the range of 233-860 μM, which are strongly active comparing with the previously reported natural inhibitor which shows IC₅₀ values in the range of 148-1000 μM. Among these, the prenylated flavonoids 1 & 2 have shown IC₅₀ values of 233 & 450 μM, respectively, while both of them were found to be inactive against thrombin. The compounds 4 & 5 showed low inhibitory activity against PEP with IC₅₀ values of 860 and 675 μM, respectively. On the other hand the compounds 4 and 5 also showed inhibitory activity against thrombin with IC₅₀ values 665 and 875 μM, respectively [Anis et al, Chem Pharm Bull, 2002, 50, 515-18].

### Efficacy of 'Phyto Soya' during menopause

A soy preparation named 'Phyto Soya' (capsules containing 17.5 mg isoflavones) is rich in isoflavones. Albert and others from Spain carried out a multicentric, open, prospective, observational and no-randomised clinical trial with 190 post-menopausal women. The main object of the study was to investigate its efficacy in alleviating the symptomatology derived from the lack of oestrogen, mainly hot flushes, but also other symptoms such as sleep disorder, anxiety, depression, vaginal dryness, loss of libido and bone pain. Each patient received 35 mg isoflavones per day in two doses. During the four months’ treatment, a statistically significant decrease in the number of hot flushes with 'Phyto Soya' was experienced by 81% women, only 5% patients did not improve with the treatment. The average reduction was 48%, which is equivalent to 4 hot flushes. All the other studied parameters also showed a statistically significant decrease. No severe side-effects were reported and tolerance was excellent. Treatment with ‘Phyto Soya’ resulted in a significant improvement of the symptomatology that accompanies the lack of estrogen during menopause [Albert et al, Phytomedicine, 2002, 9(2), 85-92].
Antimutagenic and anticarcinogenic effects of **Phyllanthus**

Sripanidkulchai and others examined the antimutagenic and anticarcinogenic potential of this plant using the bacterial pre-incubation mutation assay and an **in vivo** alkaline elution method for DNA single strand breaks in hamster liver cells. The aqueous extract of the entire plant showed an antimutagenic effect against induction by 2-aminofluorene (AF$_2$), 2-aminoanthracene (2AA) and 4-nitroquinoline-1-oxide (4-NQO) in Salmonella typhimurium strains TA98 and TA100, and in Escherichia coli WP2 uvrA/pKM101. All the results were dose-dependent; however, inhibition of N-ethyl-N-nitrosoguanidine (ENNG)-induced mutagenesis was observed only with S. typhimurium TA100. The extract also exhibited activity against 2-nitrofluorene (2NF) and sodium azide-induced mutagenesis with S. typhimurium TA98 and TA100, respectively. Based on the alkaline elution method, the plant extract prevented **in vivo** DNA single-strand breaks caused by dimethyl nitrosamine (DMN) in hamster liver cells. When an extract was administered 30 min prior to the administration of DMN, the elution rate constant decreased more than 2.5 times, compared to that of control. These results indicate that the plant possesses antimutagenic and antigenotoxic properties [Sripanidkulchai et al, Phytomedicine, 2002, 9(1), 26-32].

**Fennel oil against nail-infective fungi**

Fungal nail infections (onychomycosis) may be caused by dermatophytes, yeasts or non-dermatophytic moulds. Trichophyton rubrum (TR) is the commonest nail pathogen, accounting for 80% of all dermatophytic nail infections, followed by T. mentagrophytes (TM) and Epidermophyton floccosum (EF). Onychomycosis occurs more frequently than subcutaneous and systemic mycoses and remains a therapeutic problem in tropical and subtropical countries. Synthetic antifungal agents are largely nonrenewable petro-products that are non-biodegradable and cause adverse effects and residual toxicity. In a meaningful search for new treatments with better and cheaper substitutes, Patra and others explored plant resources.

During antifungal screening of some essential oils, Fennel, *Foeniculum vulgare* Mill. exhibited the strongest activity, completely inhibiting the mycelial growth of the nail-infective fungi TR, TM and Scytalidium dimidiatum. The essential oil was found to be fungicidal at 0.2, 0.4, and 0.5 μl/ml concentrations. The oil was effectively active against heavy doses of inoculum at minimum fungicidal concentrations. The fungicidal activity was found to be thermostable up to 80°C, with no discernible decrease in activity after 48 months of storage. The oil also showed a broad fungitoxic spectrum, inhibiting the mycelial growth of other nail-infective fungi as well. Moreover, it did not exhibit any adverse effects on mammalian skin and nails up to 5% concentration. As such, the oil has a potential use as an effective herbal chemotherapeutic after undergoing successful clinical trials, which are in progress [Patra et al, Flav Frag J, 2002, 17(2), 91-94].
Antioxidant properties of Anantmul

_Hemidesmus indicus R._
Br. Hindi- _Anantmul_, is a well known drug in Ayurveda. Traditionally the root is considered to be demulcens, diaphoretic, diuretic and tonic. It is also used in loss of appetite, fever, skin diseases, leucorrhoea, syphilis and rheumatism. Root has anti-microbial properties and potent anti-inflammatory activity. Ethanolic extract of root was found to be antihepatotoxic.

The role of free radicals in many disease conditions has been well established. Several biochemical reactions in our body generate reactive oxygen species and these are capable of damaging crucial biomolecules. If they are not effectively scavenged by cellular constituents, they lead to disease conditions. In recent years one of the areas, which attracted a great deal of attention, is antioxidant in the control of degeneration diseases in which oxidative damage has been implicated. Several plant extracts and different classes of phytochemical have been shown to have antioxidant activity. Ravishankara and others investigated antioxidant activity of methanolic extract of _Anantmul_ root bark in quenching free radicals, viz., superoxide, hydroxyl and nitric oxide radicals, that are generated in several _in vitro_ and _ex vivo_ models.

The extract was found to have different levels of antioxidant properties in the models tested. In scavenging diphenyl picryl hydrazyl and superoxide radicals, its activity was intense (EC<sub>50</sub> = 18.87 and 19.9 μg/ml, respectively) while in scavenging NO radical, it was moderate. It also inhibited lipid peroxidation of liver homogenate (EC<sub>50</sub> = 43.8 μg/ml) and the haemolysis induced by phenylhydrazine (EC<sub>50</sub> = 9.74 μg/ml) confirming the membrane stabilization activity. The free radical scavenging property may be one of mechanisms by which this drug is effective in traditional medicine [Ravishankara _et al._, _Phytomedicine_, 2002, 9(2), 153-160].

Cytotoxic glycosides from ginseng

Ginseng, the root of _Panax ginseng C.A. Meyer_, is one of the most widely used herbal medicines. Recently, it has been observed that steaming ginseng at high temperature enhances its biological activity. The processed ginseng (SG) exhibited greatly enhanced vasorelaxation activity and cancer chemoprevention activity. Park and others from College of Pharmacy, Seoul, South Korea studied the cytotoxic activity of SG.

Steaming ginseng at high temperature increased its cytotoxicity to SK-Hep-1 hepatoma cancer cells. Gingenosides Rg<sub>3</sub>, Rg, Rk, Rs, and Rg were the active principles. Their 50% growth inhibition concentration (GI<sub>50</sub>) values were 41, 11, 13, 37 and 13 μM, respectively. Recently, gingenoside Rg<sub>3</sub> was developed as anticancer drug in China. However, the dehydrated compounds, i.e. gingenosides Rk and Rg, have more potent activity than the hydroxylated derivative gingenoside Rg<sub>3</sub>. Cisplatin, a potent anticancer platinum complex, had a GI<sub>50</sub> value of 84 μM in the same assay conditions [Park _et al._, _Chem Pharm Bull_, 2002, 50(4), 538-40].