

Curcumin:

Li, H., Y. Che, et al. (2002). "[Effects of curcumin on proliferation and apoptosis in human hepatic cells]." *Zhonghua Gan Zang Bing Za Zhi* **10**(6): 449-51.

OBJECTIVE: **To investigate the effect of curcumin on the proliferation, cell cycle distribution and apoptosis of hepatocarcinoma cell line QGY.** METHODS: The MTT method was used to assay the biologic activities of curcumin in different times and different doses. The cell cycle distribution was detected by flow cytometric analysis. The cell ultrastructure was observed by electronic microscopy. RESULTS: Curcumin could inhibit effectively QGY in a dose- and time-dependent manner. IC(50) of curcumin to QGY was 49.50 micromol/L in 72 hours. The cell growth was arrested at S stage. Curcumin could lead to the degeneration, necrosis, and apoptosis. CONCLUSIONS: **Curcumin can interrupt the cell cycle and has a role in cytotoxicity, antiproliferation and inducing apoptosis of QGY.**

Wu, Y., Y. Chen, et al. (2002). "Anticancer activities of curcumin on human Burkitt's lymphoma." *Zhonghua Zhong Liu Za Zhi* **24**(4): 348-52.

OBJECTIVE: **To study the anticancer activities of curcumin on human Burkitt's lymphoma and their molecular mechanism.** METHODS: The effect of curcumin on the growth of CA46 cells and apoptosis were studied through Trypan blue exclusion, MTT assay, cell cycle, DNA fragmentation analysis and detection of TdT-mediated dUTP nick end labeling (TUNEL). **The effect of curcumin on the expression of c-myc, bcl-2, mutant-type p53 and Fas protein and mRNA was studied by flow cytometry (FCM) and reverse transcription-polymerase chain reaction (RT-PCR).** RESULTS: 1. Curcumin inhibited proliferation of CA46 cells in a time- and dose-dependent manner, 2. CA46 cells treated with curcumin showed G(0)/G(1) or G(2)/M phase increase and S phase decrease, 3. CA46 cells apoptosis induced by curcumin was confirmed by DNA fragmentation and TUNEL and 4. The expression of c-myc, bcl-2, mutant-type p53 protein and mRNA was decreased sharply in CA46 cells treated with curcumin, while Fas protein and mRNA was increased. CONCLUSION: **Curcumin is able to inhibit the proliferation of CA46 cells and induce the cell apoptosis by down-regulating the expression of c-myc, bcl-2, mutant-type p53 and up-regulating the expression of Fas.**

Inano, H., M. Onoda, et al. (2000). "Potent preventive action of curcumin on radiation-induced initiation of mammary tumorigenesis in rats." *Carcinogenesis* **21**(10): 1835-41.

This investigation evaluated the preventive effect of curcumin on radiation-induced tumor initiation in rat mammary glands. Fifty-four female rats were

mated and then divided into two groups at day 11 of pregnancy. As the control group, 27 rats were fed a basal diet during the experimental period. As the experimental group, 27 rats were fed a diet containing 1% curcumin between day 11 of pregnancy and parturition (day 23 of pregnancy). All rats of both groups received whole body irradiation with 1.5 Gy gamma-rays from a (60)Co source at day 20 of pregnancy and were then implanted with a diethylstilbestrol pellet 1 month after weaning. A high incidence (70.3%) of mammary tumorigenesis was observed in the control group. The tumor incidence (18.5%) was significantly reduced in the rats fed curcumin during the initiation stage. The appearance of the first palpable tumor was delayed by 6 months in the curcumin-fed group and the average latent period until the appearance of mammary tumors was 2.5 months longer in the curcumin-fed group than in the control group. By histological examination, the proportion of adenocarcinoma (16.7%) in total tumors in the curcumin-fed rats was found to be decreased to half that (32.1%) in the control group. Compared with the control rats, the body weight of rats in the experimental group was decreased slightly by administration of the curcumin diet from day 11 of pregnancy, in spite of a similar intake of diet, but had recovered to the level of the control by the end of the experiment. At the time of irradiation, curcumin did not have any effect on organ weight or on the development and differentiation of mammary glands of pregnant rats. In addition, the serum concentrations of fatty acids, thiobarbituric acid-reactive substances and ovarian and pituitary hormones, except LH, remained at the control level. Also, no change in litter size and body weight of pups born from curcumin-fed rats indicated no toxicity of curcumin. **These results suggest that curcumin does not have any side-effects and is an effective agent for chemoprevention acting at the radiation-induced initiation stage of mammary tumorigenesis.**

Arbiser, J. L., N. Klauber, et al. (1998). "Curcumin is an in vivo inhibitor of angiogenesis." *Mol Med* 4(6): 376-83.

BACKGROUND: Curcumin is a small-molecular-weight compound that is isolated from the commonly used spice turmeric. In animal models, curcumin and its derivatives have been shown to inhibit the progression of chemically induced colon and skin cancers. The genetic changes in carcinogenesis in these organs involve different genes, but curcumin is effective in preventing carcinogenesis in both organs. A possible explanation for this finding is that curcumin may inhibit angiogenesis.

MATERIALS AND METHODS: Curcumin was tested for its ability to inhibit the proliferation of primary endothelial cells in the presence and absence of basic fibroblast growth factor (bFGF), as well as its ability to inhibit proliferation of an immortalized endothelial cell line. Curcumin and its derivatives were subsequently tested for their ability to inhibit bFGF-

induced corneal neovascularization in the mouse cornea. Finally, curcumin was tested for its ability to inhibit phorbol ester-stimulated vascular endothelial growth factor (VEGF) mRNA production. RESULTS: Curcumin effectively inhibited endothelial cell proliferation in a dose-dependent manner. Curcumin and its derivatives demonstrated significant inhibition of bFGF-mediated corneal neovascularization in the mouse. Curcumin had no effect on phorbol ester-stimulated VEGF production. CONCLUSIONS: **These results indicate that curcumin has direct antiangiogenic activity in vitro and in vivo. The activity of curcumin in inhibiting carcinogenesis in diverse organs such as the skin and colon may be mediated in part through angiogenesis inhibition.**

Chen, H., Z. S. Zhang, et al. (1999). "Curcumin inhibits cell proliferation by interfering with the cell cycle and inducing apoptosis in colon carcinoma cells." Anticancer Res **19**(5A): 3675-80.

It has been reported that curcumin (diferuloylmethane) could inhibit growth of several types of malignant cells both in vitro and in vivo. However, the mechanism of its action is unknown. In this study, we investigated the inhibitory effects of curcumin on human colon carcinoma cell (Lovo) growth and its mechanism of action in vitro by means of growth assay, colony formation assay, MTT assay, cell cycle and apoptosis analysis. **Curcumin inhibited cell growth in a dose-dependent manner.** The ability of Lovo cells treated with curcumin to form colonies was depressed. MTT test showed that curcumin was cytotoxic to cells. Lovo cells treated with curcumin were largely accumulated in S, G2/M phase which prevented cells from entering the next cell cycle. Apoptosis induced by curcumin was confirmed by characteristic ladders and cellular morphological changes. Curcumin can inhibit Lovo cells growth and the cellular mechanism responsible for the action is to arrest the cell cycle in S, G2/M phase and to induce apoptotic cell death.

Menon, L. G., R. Kuttan, et al. (1999). "Anti-metastatic activity of curcumin and catechin." Cancer Lett **141**(1-2): 159-65.

The inhibitory effects of curcumin and catechin on lung metastasis induced by B16F-10 melanoma cells were studied in female C57BL/6 mice. Curcumin and catechin significantly ($P < 0.001$) inhibited lung tumour formation (89.3% and 82.2%, respectively) and significantly increased the life span (143.9% and 80.8%, respectively). Moreover, lung collagen hydroxyproline and serum sialic acid levels were found to be significantly ($P < 0.001$) lower in treated animals compared to the untreated controls. **Curcumin and catechin treatment (10 microg/ml) significantly inhibited the invasion of B16F-10 melanoma cells across the collagen matrix of the Boyden chamber.** Gelatin zymographic analysis of the trypsin-activated B16F-10 melanoma cells sonicate revealed that

curcumin- and catechin-treated zymograms did not show any metalloproteinase activity. Curcumin and catechin treatment did not inhibit the motility of B16F-10 melanoma cells across a polycarbonate filter in vitro. These findings suggest that curcumin and catechin inhibit the invasion of B16F-10 melanoma cells by inhibition of metalloproteinases, thereby inhibiting lung metastasis.

Lambert, J. D., J. Hong, et al. (2005). "Inhibition of carcinogenesis by polyphenols: evidence from laboratory investigations." *Am J Clin Nutr* **81**(1 Suppl): 284S-291S.

Many plant polyphenolic compounds have been shown to have cancer-preventing activities in laboratory studies. For example, tea and tea preparations have been shown to inhibit tumorigenesis in a variety of animal models of carcinogenesis, involving organ sites such as the skin, lungs, oral cavity, esophagus, stomach, liver, pancreas, small intestine, colon, and prostate. In some of these models, inhibitory activity was demonstrated when tea was administered during the initiation, promotion, or progression stage of carcinogenesis. **The cancer-preventing activities of these and other polyphenols, such as curcumin, genistein, and quercetin, are reviewed.** In studies in vitro, many of these compounds have been shown to affect signal transduction pathways, leading to inhibition of cell growth and transformation, enhanced apoptosis, reduced invasive behavior, and slowed angiogenesis. However, the concentrations used in cell culture studies were much higher than those found in vivo. If we propose mechanisms for cancer prevention on the basis of cell line experiments, then these activities must be demonstrated in vivo. The bioavailability, ie, tissue and cellular concentrations, of dietary polyphenols is a determining factor in their cancer-preventing activity in vivo. **For example, compounds such as curcumin are effective when applied topically to the skin or administered orally to affect the colon but are not effective in internal organs such as the lungs.** More in-depth studies on bioavailability should facilitate correlation of mechanisms determined in vitro with in vivo situations, increase our understanding of dose-response relationships, and facilitate extrapolation of results from animal studies to human situations.

Dorai, T., J. P. Dutcher, et al. (2004). "Therapeutic potential of curcumin in prostate cancer--V: Interference with the osteomimetic properties of hormone refractory C4-2B prostate cancer cells." *Prostate* **60**(1): 1-17.

BACKGROUND: There is increasing evidence that the stringent selective pressure imposed by androgen ablation therapy on the residual prostate cancer cells may actually accelerate the

development of the hormone refractory and bone metastatic phenotype. The propensity of prostate cancer to establish osseous metastases is very likely mediated by the osteomimetic properties of the prostate cancer cells. Prostate cancer cells acquire these "bone-like" properties in order to survive in the bony microenvironment. This process is facilitated by common growth factor trophisms between the bone stromal cells, osteoblasts, and the prostate cancer cells wherein a number of growth factors and their receptors are involved. **Thus, a general inhibition of the tyrosine kinase signaling pathways may have a therapeutic advantage in interfering with the metastatic potential of these prostate cancer cells. This study focuses on the potential of curcumin, a plant based non-toxic tyrosine kinase inhibitor in interfering with the development of bone like properties of C4-2B, a highly metastatic derivative of LNCaP prostate cancer cell line.**

METHODS: C4-2B prostate cancer cells were analyzed for their constitutive expression and ligand inducible activation of growth factor receptors such as EGF-R and CSF1-R. Expression of bone-specific transcription factors such as Cbfa-1 and the production of PTHRP were followed. The ability of the C4-2B cells to mineralize under specific conditions was analyzed. The activation status of the transcription factor NF-kappa B was also followed. **RESULTS:** Curcumin inhibited the ligand-stimulated autophosphorylation of EGF-R and CSF1-R that were crucially involved in the development of osteomimetic properties of C4-2B cells. When C4-2B cells were grown under promineralization conditions, curcumin prevented the formation of the mineralized nodules. It also inhibited the expression of the core-binding factor α -1 in C4-2B cells which was responsible for the expression of several bone-specific proteins. The IKK activity was severely impaired, **showing marked NF-kappa B inhibition.** The experiments indicate that curcumin can also interfere with the development of the osteoblast and the osteoclast-like properties by these prostate cancer cells. **CONCLUSIONS:** The highly metastatic C4-2B prostate cancer cell line is already "programmed" to exhibit the bone-like properties that would at least in part explain its affinity to set up osseous metastases. Curcumin is able to interfere with the osteoblastic component as well as the osteoclastic component of this phenotype, by interfering with the growth factor receptor pathways and by inhibiting the NF-kappa B activation process. **It is concluded that curcumin may inhibit the growth factor collaboration between the prostate cancer cells and the osteoblast/stromal cells, thus exhibiting a potential to prevent the establishment of bony metastases.**

Dorai, T., N. Gehani, et al. (2000). "Therapeutic potential of curcumin in human prostate cancer-I. curcumin induces apoptosis in both androgen-dependent and androgen-independent prostate cancer cells." Prostate Cancer Prostatic Dis **3**(2):

84-93.

In an effort to find an alternative nontoxic means of inducing the apoptosis potential in both androgen-dependent and hormone refractory prostate cancer cells, attention was focused on curcumin (turmeric), traditionally used in medicine and cuisine in India and other south-east Asian countries. The results indicate that curcumin is a novel and potent inducer of apoptosis in both androgen-dependent and androgen-independent prostate cancer cells. This was accomplished by down-regulating apoptosis suppressor proteins and other crucial proteins such as the androgen receptor. **It is concluded that curcumin may provide an alternative, nontoxic modality by which the clinician may prevent the progression of prostate cancer to its hormone refractory state or to treat advanced prostate cancer by forcing them to undergo apoptosis.** Prostate Cancer and Prostatic Diseases (2000) 3, 84-93

Sharma, R. A., H. R. McLelland, et al. (2001). "Pharmacodynamic and pharmacokinetic study of oral Curcuma extract in patients with colorectal cancer." Clin Cancer Res 7(7): 1894-900.

Curcuma spp. extracts, particularly the dietary polyphenol curcumin, prevent colon cancer in rodents. In view of the sparse information on the pharmacodynamics and pharmacokinetics of curcumin in humans, a dose-escalation pilot study of a novel standardized Curcuma extract in proprietary capsule form was performed at doses between 440 and 2200 mg/day, containing 36-180 mg of curcumin. Fifteen patients with advanced colorectal cancer refractory to standard chemotherapies received **Curcuma extract daily for up to 4 months. Activity of glutathione S-transferase and levels of a DNA adduct** (M(1)G) formed by malondialdehyde, a product of lipid peroxidation and prostaglandin biosynthesis, were measured in patients' blood cells. Oral Curcuma extract was well tolerated, and dose-limiting toxicity was not observed. Neither curcumin nor its metabolites were detected in blood or urine, but curcumin was recovered from feces. Curcumin sulfate was identified in the feces of one patient. **Ingestion of 440 mg of Curcuma extract for 29 days was accompanied by a 59% decrease in lymphocytic glutathione S-transferase activity.** At higher dose levels, this effect was not observed. Leukocytic M(1)G levels were constant within each patient and unaffected by treatment. Radiologically stable disease was demonstrated in five patients for 2-4 months of treatment. The results suggest that (a) **Curcuma extract can be administered safely to patients at doses of up to 2.2 g daily, equivalent to 180 mg of curcumin;** (b) curcumin has low oral bioavailability in humans and may undergo intestinal metabolism; and (c) larger clinical trials of Curcuma extract are merited.

Dorai, T., Y. C. Cao, et al. (2001). "Therapeutic potential of curcumin in human prostate cancer. III. Curcumin inhibits proliferation, induces apoptosis, and inhibits angiogenesis of LNCaP prostate cancer cells in vivo." *Prostate* **47**(4): 293-303.

BACKGROUND: Earlier work from our laboratory highlighted the therapeutic potential of curcumin (turmeric), used as a dietary ingredient and as a natural anti-inflammatory agent in India and other Southeast Asian countries. This agent was shown to decrease the proliferative potential and induce the apoptosis potential of both androgen-dependent and androgen-independent prostate cancer cells in vitro, largely by modulating the apoptosis suppressor proteins and by interfering with the growth factor receptor signaling pathways as exemplified by the EGF-receptor. To extend these observations made in vitro and to study the efficacy of this potential anti-cancer agent in vivo, the growth of LNCaP cells as heterotopically implanted tumors in nude mice was followed. **METHODS:** The androgen-dependent LNCaP prostate cancer cells were grown, mixed with Matrigel and injected subcutaneously into nude mice. Experimental group received a synthetic diet containing 2% curcumin for up to 6 weeks. At the end point, sections taken from the excised tumors were evaluated for pathology, cell proliferation, apoptosis, and vascularity. **RESULTS:** **Curcumin causes a marked decrease in the extent of cell proliferation as measured by the BrdU incorporation assay and a significant increase in the extent of apoptosis as measured by an in situ cell death assay.** Moreover, a significant decrease in the microvessel density as measured by the CD31 antigen staining was also seen. **CONCLUSIONS:** Curcumin could be a potentially therapeutic anti-cancer agent, as it significantly inhibits prostate cancer growth, as exemplified by LNCaP in vivo, and has the potential to prevent the progression of this cancer to its hormone refractory state.

Moragoda, L., R. Jaszewski, et al. (2001). "Curcumin induced modulation of cell cycle and apoptosis in gastric and colon cancer cells." *Anticancer Res* **21**(2A): 873-8.

We have investigated the chemopreventive role of curcumin in gastrointestinal cancers by studying the regulation of proliferation and apoptosis in gastric (KATO-III) and colon (HCT-116) cancer cells. **Curcumin inhibited cell proliferation and induced G2/M arrest in HCT-116 cells.** Investigation of the levels of cyclins E, D and B by immunoblot analysis showed cyclin B level was unaffected, whereas cyclin D and E levels declined with curcumin in both cell lines. Investigation of cyclin-dependent kinases, Cdk2 and Cdc2, showed activity of Cdc2, but not Cdk2, increased markedly in response to curcumin. **In both cell lines, immunoblot analysis indicated that curcumin caused induction of apoptosis as evidenced by cleavage of PARP, caspase-3, and**

reduction in Bcl-XL levels. Curcumin also stimulated the activity of caspase-8, which initiates Fas signalling pathway of apoptosis. **Curcumin therefore appears to exert its anticarcinogenic properties by inhibiting proliferation and inducing apoptosis in certain gastric and colon cancer cells.**

Dorai, T., N. Gehani, et al. (2000). "Therapeutic potential of curcumin in human prostate cancer. II. Curcumin inhibits tyrosine kinase activity of epidermal growth factor receptor and depletes the protein." *Mol Urol* 4(1): 1-6.

PURPOSE: In a search for alternative and preventive therapies for prostate cancer, attention was focused on the ways in which curcumin (Turmeric), used in food and medicine in India for centuries, could interfere with the growth factor signaling pathways in both androgen-dependent and androgen-independent prostate cancer cells, as exemplified by the epidermal growth factor receptor (EGF-R) signaling. **MATERIALS AND METHODS:** The androgen-sensitive LNCaP and androgen-insensitive PC-3 cell lines were grown in 5 to 50 microM curcumin and analyzed for EGF-R protein by Western blotting and for EGF-R tyrosine kinase activity.

RESULTS: Curcumin was a potent inhibitor of EGF-R signaling, and it accomplished this effect by three different means (1) down regulating the EGF-R protein; (2) inhibiting the intrinsic EGF-R tyrosine kinase activity; and (3) inhibiting the ligand-induced activation of the EGF-R.

CONCLUSIONS: **These results, taken together with our previous results that curcumin can induce apoptosis in both androgen-dependent and androgen-independent prostate cancer cells, support our view that curcumin may be a novel modality by which one can interfere with the signal transduction pathways of the prostate cancer cell and prevent it from progressing to its hormone-refractory state.**

Navis, I., P. Sriganth, et al. (1999). "Dietary curcumin with cisplatin administration modulates tumour marker indices in experimental fibrosarcoma." *Pharmacol Res* 39(3): 175-9.

Curcumin, the active constituent of Curcuma longa, which itself possesses antitumour activity against experimental tumours, enhances the antitumour effect of the widely used anticancer drug cisplatin, when used in combination against fibrosarcoma. Tumour marker enzymes such as aminotransferases, lactate dehydrogenase, gamma-glutamyl transpeptidase, alkaline phosphatase, 5'-nucleotidase were analysed in liver and kidney homogenates of experimental rats. All these enzyme activities were markedly increased in tumour bearing animals. On cisplatin administration, the enzyme levels were decreased but not to near normal values. **Curcumin, when treated along with cisplatin brought back the enzyme levels to near the control values.**

Thus curcumin and cisplatin combination may be worth trying against tumours like fibrosarcoma.

Kuttan, R., P. C. Sudheeran, et al. (1987). "Turmeric and curcumin as topical agents in cancer therapy." Tumori **73**(1): 29-31.

An ethanol extract of turmeric ("Curcuma longa") as well as an ointment of curcumin (its active ingredient) were found to produce remarkable symptomatic relief in patients with external cancerous lesions. Reduction in smell were noted in 90% of the cases and reduction in itching in almost all cases. Dry lesions were observed in 70% of the cases, and a small number of patients (10%) had a reduction in lesion size and pain. In many patients the effect continued for several months. An adverse reaction was noticed in only one of the 62 patients evaluated.

Miyoshi, N., Y. Nakamura, et al. (2003). "Dietary ginger constituents, galanals A and B, are potent apoptosis inducers in Human T lymphoma Jurkat cells." Cancer Lett **199**(2): 113-9.

The effects of the constituents isolated from ginger species including curcumin, 6-gingerol and labdane-type diterpene compounds on cell proliferation and the induction of apoptosis in the cultured human T lymphoma Jurkat cells were studied. Among the tested compounds, galanals A and B, isolated from the flower buds of a Japanese ginger, myoga (*Zingiber mioga* Roscoe), showed the most potent cytotoxic effect. Exposure of Jurkat human T-cell leukemia cells to galanals resulted in the induction of apoptotic cell death characterized by DNA fragmentation and caspase-3 activation. The mitochondrial damage pathway was suggested to be involved in galanal-induced apoptosis because the treatment of cells with galanals induced mitochondrial transmembrane potential ($\Delta\psi$) alteration and cytochrome c release. The anti-apoptotic Bcl-2 protein was downregulated by the galanal treatment together with enhancement of the Bax expression. In conclusion, the results from this study provide biological evidence that ginger-specific constituents other than curcuminoids are potential anticancer agents.

Piwocka, K., E. Jaruga, et al. (2001). "Effect of glutathione depletion on caspase-3 independent apoptosis pathway induced by curcumin in Jurkat cells." Free Radic Biol Med **31**(5): 670-8.

Curcumin, a yellow pigment from *Curcuma longa*, exhibits anti-inflammatory, antitumor, and antioxidative properties. Although its precise mode of action has not been elucidated so far, numerous studies have shown that curcumin may induce apoptosis in normal and cancer cells. Previously, we showed that in Jurkat cells curcumin induced nontypical apoptosis-like pathway, which was independent of mitochondria and

caspase-3. Now we show that the inhibition of caspase-3 by curcumin, which is accompanied by attenuation of internucleosomal DNA fragmentation, may be due to elevation of glutathione, which increased in curcumin-treated cells to 130% of control. We have demonstrated that glutathione depletion does not itself induce apoptosis in Jurkat cells; though, it can release cytochrome c from mitochondria and caspase-3 from inhibition by curcumin, as shown by Western blot. The level of Bcl-2 protein was not affected by glutathione depletion even upon curcumin treatment. Altogether, our results show that in Jurkat cells **curcumin prevents glutathione decrease, thus protecting cells against caspase-3 activation and oligonucleosomal DNA fragmentation. On the other hand, it induces nonclassical apoptosis via a still-unrecognized mechanism, which leads to chromatin degradation and high-molecular-weight DNA fragmentation.**

Chen, J. C., J. M. Hwang, et al. (2003). "Curcumin decreases the DNA adduct formation, arylamines N-acetyltransferase activity and gene expression in human colon tumor cells (colo 205)." *In Vivo* **17**(3): 301-9.

The effects of curcumin on the N-acetyltransferase (NAT) activity, AF-DNA adduct formation and NAT gene expression were examined using the human colon tumor cell line (colo 205). Various concentrations of curcumin were added to the cytosols or to the medium of human colon tumor cells. The NAT activity was determined by high performance liquid chromatography assaying for the amounts of acetylated 2-aminofluorene (AAF) and p-aminobenzoic acid (N-Ac-PABA) and nonacetylated 2-aminofluorene (AF) and p-aminobenzoic acid (PABA). **The NAT activity in the human colon tumor cells and cytosols was suppressed by curcumin in a dose-dependent manner. The results demonstrated that gene expression (NAT1 mRNA) in human colon tumor cells was inhibited by curcumin.** The apparent values of K_m and V_{max} of NAT of human colon tumor cells were also decreased by curcumin in cytosols. Curcumin may act as a noncompetitive inhibitor. After the incubation of human colon tumor cells with AF with or without curcumin cotreatment, the cells were recovered and DNA was prepared, hydrolyzed to nucleotides, the adducted nucleotides were extracted into butanol and AF-DNA adducts analyzed by HPLC. The results also demonstrated that when curcumin was added to the media a decrease in AF-DNA adduct formation was seen in the human colon tumor cells. The finding of AF-DNA adduct formation in cultured human colon tumor cells suggests the usefulness of cultured cells for assessing arylamine-induced DNA damage.