Online table 1 | **Selected examples of phytochemicals with chemopreventive potential**

Phytochemical	Biological effects	Molecular target effects	Animal model/cell types	References
Curcumin				
	Inhibition of carcinogen activation and DNA binding	↓ CYP1A1 activity; DMBA–DNA adduct formation	Human breast cancer (MCF-7) cells treated with DMBA	1
		↓ Cyp1a1 activity	Mouse liver	2
		↓ Cyp1a1/1a2 activity	Rat liver	3
	Stimulation of carcinogen detoxification	↑ Gst activity	Rat liver	4
		↑ Qr activity	Mouse hepatoma (Hepa 1c1c7) cells	5
		↑ Gst and Eh activity	Mouse liver	2
		↑ GCL expression and NRF2 nuclear translocation	Human bronchial epithelial (HBE1) cells	6
	Control of cell cycle and proliferation	↓ Cyclin D1 expression and RB phosphorylation	Prostate, breast, squamous carcinoma cells	7
		↓ *EGR1*, c-*MYC*, *BCL-X*$_L$, and *TP53* mRNA expression; ↓ NF-κB activation	B-cell lymphoma	8
		↓ c-Jun and c-Fos expression	Mouse epidermal (JB6) cells; TPA-treated mouse skin	9
	Induction of apoptosis and/or differentiation	↓ NF-κB and IKK activity, phosphorylation of IκBα; ↓ BCL2, BCL-X$_L$, cyclin D1 and IL-6; ↑ caspase-7,9 activity	Human multiple myeloma cells	10
		↑ p53 and BAX expression	Human breast cancer cells	11
		↑ caspase-8,3 activity and BID cleavage; ↑ cytochrome *c* release	Human promyelocytic leukaemia (HL-60) cells	12
	Inhibition of the activity of oncogene products	↓ c-Myc, c-Fos and c-Jun expression	Mouse skin	13
	Inhibition of angiogenesis, metastasis and invasion	↓ *MMP2*, *VEGF* and *FGF2* mRNA expression; ↑ *TIMP1* mRNA expression	Human breast carcinoma (MDA-MB-231) cells	14
		↓ uPa expression and fibronectin synthesis	Mouse epidermal keratinocytes	15
		↓ MMP9 expression	Human hepatocellular (SK-HEP1) carcinoma cell	16
Capsaicin				
	Inhibition of carcinogen activation and DNA binding	↓ Cyp2a2/3a1/2c11/2b1 /2b2/2c6 activity	Hamster and rat liver	17
		↓ Cyp2e1 activity	Rat liver S-9	18
	Stimulation of carcinogen detoxification	↑ Gst and Qr activity	Rat tongue tumorigenesis model	19
			Azoxymethane-induced rat rat colon tumour	20
	Downregulation of proliferation	↑ TAX degradation; ↓ BCL2 expression and NF-κB activity	Human T-cell leukaemia cells	21
		↓ NF-κB activity and IL-8 expression	Human malignant melanoma cells	22
		↓ Nf-κb and Ap1 activation	Mouse skin *in vivo*	23
		↓ Nf-κb and Ap1 DNA binding	HL-60 cells	24
		↓ NADH oxidase activity	HL-60 cells and ovarian carcinoma	25
		↑ PKC activity	Human and mouse melanoma	26
			HL-60 cells	27
	Induction of apoptosis/cell-cycle arrest	↓ BCL2 expression; ↑caspase-3 activity	SK-Hep-1 hepatocellular carcinoma cells	28
		↑ JNK activity and ROS	Jurkat cell	29,30
		↑ JNK and p38 MAPK activity	*RAS*-transformed human breast epithelial cells	31
		↓ Mitochondrial permeability transition	Human squamous-cell carcinoma cells	32
	Inhibition of angiogenesis, metastasis and invasion	↑ HIF-1α activity and *VEGF* mRNA expression	Human malignant melanoma cells	33
[6]-Gingerol				
	Inhibition of TPA-induced tumour promotion	↓ Odc activity	ICR mouse skin	34
	Induction of apoptosis		HL-60 cells	35
	Inhibition of cell transformation	↓ Ap1 activation	JB6 cells	36
	Inhibition of lung metastasis		Mouse bearing melanoma (B16) cells	37

EGCG				
	Inhibition of carcinogen activation and DNA binding	↓ CYP protein expression	Human hepatoma (HepG2) cells	38
		↓ NADPH-P450 reductase	Genetically engineered *Salmonella typhimurium* harbouring human *CYP* and NADPH-P450 reductase	39
		↓ AHR binding to DNA; ↓ *CYP1A1/2* mRNA expression	HepG2 cells	40
	Control of cell cycle	↑ p21, KIP1, p16 and p18 expression; ↓ cyclin D1 and CDK2,4,6 expression and activity	Human epidermoid carcinoma (A431) cells	41
		↑ p21, KIP1, p16 and p18 expression; ↓ CDK2,4,6 expression; ↓ cyclin D1 and E protein expression; ↓ cyclin E binding to CDK2; ↑ binding of cyclin D1 towards p21 and KIP1	Human prostate carcinoma	42,43
		↑ p21, p53 and KIP1 protein expression; ↓ CDK2,4 activity	MCF-7 cells	44
	Control of proliferation	↓ phosphorylation of Erk1/2, Mek1/2 and Elk1	*RAS*-transformed JB6 cells	45
		↓ Cox2 and cyclin D1 expression; ↓ Pge_2 production	NMBA-treated F344 rats	46
		↓ Phosphorylation of ERBB2, AKT and GSK3α–GST	ERBB2-overexpressing breast cancer cells	47
		↓ ODC expression; ↓MAPK and tyrosine kinase activity	*RAS*-transformed (NIH-pATM) fibroblasts	48
	Induction of apoptosis and/or differentiation	↓ Expression of BCL2 and cyclin D1; ↑ BAX, p21 and KIP1 expression; ↓ phosphorylation of EGFR, STAT3 and ERK	Head and neck squamous carcinoma cells	49
		↑ ROS formation and mitochondrial depolarization	Human prostate cancer (DU145) cells	50
		↑ FAS/FASL activity; ↑ Expression of p53 and p21	HepG2 cells	51
		↓ E2F level and RB phosphorylation	A431 cells	52
		↓ NF-κB expression/activation	A431 cells	
		↑ Caspase-3 activity	Human cervical squamous carcinoma (HeLa) cells	50,54
			HepG2 cells	54
	Inhibition of oncogene expression/activity	↓ *Pkc* and c-*Myc* expression	TPA-treated mouse skin	55
	Inhibition of angiogenesis, metastasis and invasion	↓ VEGF expression	Human colon cancer cells	56
		↓ VEGF binding to receptor	Human umbilical-vein endothelial cells	57
		↓ MMP activity	Human umbilical-vein endothelial cells	58
		↓ NF-κB, and STAT activity; ↓ VEGF production	Human head and neck and breast carcinoma cells	59
		↓ VE-cadherin phosphorylation; ↓ AKT activity	Human microvascular endothelial cells	60
		↓ MMP2,9 and gelatinase activity	Human neuroblastoma and fibrosarcoma cells	61
Genistein				
	Inhibition of carcinogen activation and DNA binding	↓ DBP–DNA adduct formation	MCF-7 cells	62
		↓ *CYP3A4* mRNA level	Human colon carcinoma (Caco-2) cells	63
		↓ *CYP27b1* expression	C57BL/6 mouse colon	64
	Stimulation of carcinogen detoxification	↑ *QR* mRNA expression and activity	Human colon cancer (Colo205) cells	65
		↑ *GPX* mRNA expression and activity	Human prostate (LNCap, PC-3) cancer cells	66
	Control of cell cycle and proliferation	↑ Phosphorylation of ATM, p53 and CHK2	Lymphoblastoid cells	67
		↓ c-FOS expression; ↓ AP1 and ERK activity	Human breast cancer (MCF-7, MDA-MB-231, etc.) cells	68
		↑ p21 and KIP1 protein and mRNA expression	LNCap cells	69

		↓ CDK1 activity	Human choroidal melanoma (OCM-1) cells	70
	Induction of apoptosis and/or differentiation	↓ BCL2 expression	MCF-7 cells	71
		↓ NF-κB and AKT activity	PC3 cells	72
			Breast cancer (MDA-MB-231) cells	73
		↑ Cytochrome *c* release	Human and rat pancreatic tumour cells	74
		↑ BAX and CDKN2A expression; ↓ BCL2 and ERBB2 expression	ERBB2-expressing human breast epithelial cells	75
		↑ BAK; ↓ BCL-X_L expression	MCF-7 cells	76
		↑ BAX expression, cytochrome *c* release and caspase-3 activity; ↓ proteosome activity	p815 mastocytoma cells	77
	Inhibition of the activity of oncogene product	↓ N-Myc expression and Ptk activity	Mouse neuroblastoma (N2a) cells	78
		↓ uPA activity; ↑ PAI activity; ↓ PA/PAI ratio	N-MYC-transfected neuroblastoma cells	79
	Modulation of hormonal and growth-factor activity	↓ Prostate androgen-regulated transcript-1	LNCaP cells	80
		↓ pS2, TGF-β and ER expression	Human breast (MCF7, T47D, etc.) carcinoma cells	81
		↑ *BRCA2* mRNA	MDA-MB-231 cells	82
		↓ Cancer-cell growth by environmental oestrogens	MCF-7 cells, T47D MDA-MB-231 cells	83
		↓ Androgen and oestrogen-receptor expression	Rat prostate	84
		↓ NF-κB DNA-binding activity by HGF	HepG2 cells	85
	Inhibition of angiogenesis, metastasis and invasion	↓ MMP3,9 activity	Malignant mesothelioma cells	86
		↓ uPA and MMP-9/2 production	Ovarian cancer cells	87
		↓ *VEGF* and *FGF* mRNA expression	Human renal-cell carcinoma cells	88
Resveratrol				
	Inhibition of carcinogen activation and DNA binding	↓ Cyp1a activity;	Hepa1c1c7 cells	89
		↓ Expression and activity of CYP1A1/1A2;	Human hepatoma and breast cancer cells	90
		↓ *O*-acetyltransferase activity; ↓ PhIP–DNA adduct formation	MCF-7 cells	91
	Stimulation of carcinogen detoxification	↑ Qr activity	Hepa1c1c7 cells	89
	Control of cell proliferation	↓ NF-κB activation	MCF-7 cells	92
		↓ Cox2 and Mmp9 expression	Rat mammary carcinogenesis model	92
		↓ Cox expression and Pge_2 production	NMBA-induced rat esophageal tumour	93
		↓ PKC and ERK1 activity; ↓ *COX2* mRNA level and AP1 activity	Human mammary and oral epithelial cells	94,95
	Control of cell cycle	↑ p21 expression; ↓ cyclin D1,D2, E expression; ↓ CDK2/4/6 expression and activity; ↓ RB phosphorylation and E2F expression	A431 cells	96,97
		↓ Cyclin B1,D1, A1 and β-catenin expression	Human colon carcinoma (SW480) cells	98
		↓ Cyclin D1 and CDK4 expression; ↓RB phosphorylation	Human colon adenocarcinoma (Caco-2 and HCT-116) cells	99
	Induction of apoptosis and/or differentiation	↓ NF-κB activity; ↑ cytochrome *c* release and caspase-3 activation	Human pancreatic cancer cells	74
		↓ Lipid peroxidation, MAPK and JNK activity; ↓ NF-κB and AP1 activity; ↓ ROS generation	Human myeloid, lymphoid and epithelial cells	100
		↓ BCL2 expression	HL-60 cells	101
		↑ Expression of BAX, p21 and p53	HepG2 cells	102
		↓ BCL2 expression; ↑ BAX expression	Oesophageal (EC-9706) cancer cells	103
		↓ Iκb kinase activity and Nf-κb activation	Rat-1 cells expressing oncogenic *Hras*	104

		Co-localization of BAX with mitochondria; ↑ caspase-3,9 activity, ↓ mitochondrial membrane potential	Human colon cancer (HCT-116) cells	105
		↑ Caspase-9 activity	HL-60 cells	106
		↑ Mapks activation and p53 phosphorylation	JB6 cells	107,108
		↑ Phosphorylation of ERK1,2, ELK1 and p53	Human prostate (DU145) cells	109
		↑ Expression of CD11a, CD11b, CD18, CD54; ↑ superoxide production	Human myelod leukaemia cells	110
		↑ Expression of 53, p21, p300/CBP and APAF1	LNCaP cells	111
	Inhibition of angiogenesis, metastasis and invasion	↓ DNA synthesis; ↓ binding of Vegf to Huvec	Mice bearing Lewis cell carcinoma	112
CAPE				
	Stimulation of carcinogen detoxification	↑ Expression of NQO1 and GST Ya mediated via ARE element	HepG2 cells	113
	Control of cell proliferation	↓ ODC protein and mRNA expression; ↓ PKC activity; ↓ EGF binding and EGF receptor phosphorylation	SV40 transformed human keratinocytes	114
		↓ β-Catenin expression	*Apc* mutated (C57BL/6J-Min/+) mouse	115
	Induction of apoptosis	↑ Caspase-3 activity and BAX expression; ↓ BCL2 expression	HL-60 cells	116
		↑Caspase-3 activity	p53 mutant human lung and ovarian carcinoma cells	117
		↓ Mitochondrial membrane potential and GSH	HL-60 cells	118
		↓ GSH levels	Adenovirus transformed rat embryo fibroblasts	119
	Inhibition of angiogenesis, metastasis and invasion	↓ Phosphorylation of focal adhesion kinase and p130Cas	Human colon carcinoma cells	120
	Miscellaneous (including antioxidant gene expression)	↓ Nrf2–Keap1 complex; ↑ Nrf2 DNA binding; ↑ Ho-1 expression and activity	Porcine renal epithelial cells	121
Indole-3-carbinol				
	Inhibition of carcinogen activation and DNA binding	↓ DNA adduct formation	PhIP- and IQ-induced rat mammary tumour	122
			PhIP-induced rat colon carcinogenesis model	123
	Stimulation of carcinogen detoxification	↑ Gstt1-1 protein and mRNA expression	Dihaloalkane-treated rat liver	124
		↑ *Cyp1a1/1b1/2b1/2b2* mRNA transcription and activity	Oestrogen-treated female rats	125
	Control of cell cycle and proliferation	↓ Oestrogen receptor phosphorylation	Oestrogen-responsive human breast cancer cells	126
		↑ p21 and KIP1 protein expression; ↓ CDK6 protein expression and activity;↓ RB phosphorylation	PC-3 cells	127
	Induction of apoptosis	↑ BAX expression; ↓ BCL2 expression; ↓ AKT phosphorylation and activity; ↓ BCL-X_L, BAD expression and NF-κB DNA-binding activity	PC-3 cells	127,128
		↓ NF-κB DNA binding; AKT activation	MDA-MB-468, LNCaP cells	129
	Modulation of hormonal and growth-factor activity	↓ ER-α signalling; ↑ BRCA1 expression	MCF-7, T-47D and MDA-MB-468 cells	130,131
	Inhibition of angiogenesis, metastasis and invasion	↑ Protein expression of E-cadherin, α-, β- and γ-catenin	MCF-7 and MDA-MB-468 cells	131
		↓ PTEN expression	T-47D cells	132

Diallyl sulphide				
	Inhibition of carcinogen activation and DNA binding	↓ P450 2e1 activity	Rat liver S-9 fraction	18
	Stimulation of carcinogen detoxification	↑ Qr and Gst activity	Wistar rats tumorigenesis model	133
			Sprague-Dawley rat tissues	134
		↑ Prod and Gst activity; ↑ expression of Cyp1a1/2b1/3a1 mRNA and protein	Ethacrynic-acid-treated rat liver	135
		↑ Activity of Gst, Gpx and Gr	*t*-Butyl-hydroperoxide and H_2O_2-treated mouse stomach tissue	136
	Induction of apoptosis	↑ p53 and BAX expression; ↓ BCL2 expression	Non-small-cell lung cancer (H460 & H1299) cells	137
	Inhibition of angiogenesis,		Ehrlich ascite tumour-bearing Swiss albino mice	138
Lycopene				
	Inhibition of carcinogen activation and DNA damage	↓ 8-OHdG formation	Human prostate cancer tissue	139
	Stimulation of carcinogen detoxification	↑ Gsh, Gst, Gpx and Gr activity	DMBA-induced hamster buccal pouch carcinogenesis model	140,141
		↑ Gsh, Gst, Gpx and GR	MMNG-induced rat gastric carcinogenesis model	142
		↑ Gsh, Sod and Gpx activity	Female Wistar rats	143
	Control of cell cycle and apoptosis	↓ Cyclin D1,D3 expression and CDK2,4 activity; ↓ retention of KIP1 in cyclin-E–CDK2 complex	Human breast and endometrial cancer cells	144
		↓ Tyrosine phosphorylation of insulin receptor substrate-1; ↓ AP1 DNA binding; ↑ IGF-binding protein	MCF-7 cells	145
		↓ Proliferation	MCF-7,MDA-MB-231 cells	146
		↑ Apoptosis	HL-60 cells	147
Sulphoraphane				
	Inhibition of carcinogen activation and DNA binding	↓ Cyp2e1 activity	Rat liver microsomes	148
	Stimulation of carcinogen detoxification	↑ GST and QR protein expression; ↓ DNA adduct	Human mammary epithelial (MCF-10F) cells	149
		↑ NQO1 and AKR1C1 protein and mRNA expression	Human colon adenocarcinoma (LS-174) cells	150
		↑ Qr and Gst activity	Rat liver, colon and pancreas	151
	Induction of apoptosis and cell-cycle arrest	↓ Androgen receptors, PSA production and cyclin-D1 expression	LNCaP cells	152
		↑ Cyclin A,B and BAX expression; ↑ cytochrome *c* release	Human colon cancer (HT29) cells	153

AHR, aryl hydrocarbon receptor; APAF, apoptotic protease-activating factor; Apc, adenomatosis polyposis coli; ARE, antioxidant-response element; ATM, ataxia telangiectasia mutated; BAD, BCL2-antagonist of cell death; BAK, BCL2-homologous antagonist/killer; B[*a*]P, benzo[*a*]pyrene; BAX, BCL2-associated X protein; BCL2, B-cell CLL/lymphoma 2; BID, BH3-interacting domain death agonist; BRCA, breast cancer; CBP, cyclic AMP response element binding protein; CDC, cell-division cycle; CDK, cyclin-dependent kinase; CHK2, checkpoint 2; COX2, cyclooxygenase 2; CYP, cytochrome p450; DBP, dibenzo[*a,l*]pyrene; DMBA, 7,12-dimethylbenz[*a*]anthracene; EGCG, epigallocatechin gallate; EGR1, early growth response 1; EH, epoxide hydrolase; ER, oestrogen receptor; ERBB2, v-erb-b2 erythroblastic leukaemia viral oncogene homologue 2; ERK, extracellular-signal-regulated kinase; FASL, FAS ligand; FGF, fibroblast growth factor; GCL, glutamate-cyteine ligase; GSH, reduced glutathione; GPX, glutathione peroxidase; GR, glutathione reductase; GSK3α, glcogen synthase kinase-3α; GST, glutathione-*S*-transferase; HGF, hepatocyte growth factor; HIF-1α, hypoxia-inducible factor-1α; HO-1, haem oxygenase-1; Huvec, human umbilical vein endothelial cells; IKK, IκB kinase; IL, interleukin; JNK, c-JUN NH_2-terminal kinase; Keap1, Kelch-like ECH-associated protein-1; MAPK, mitogen-activated protein kinase; MEK, MAPK kinase; MMNG, N-methyl-N′-nitro-N-nitrosoguanidine; MMP, matrix metalloproteinase; NMBA, N-nitrosomethylbenzyamine; NQO1, NAD(P)H:quinone oxidoreductase 1; NRF2, NF-E2-related factor-2; Odc, ornithine decarboxylase; OhdG, 7,8-dihydro-8-oxo-2′-deoxyguanosine; PAI, plasminogen-activator inhibitor; PGE_2, prostaglandin E2; PhIP, 2-amino-1-methyl-6-phenylimidazol[*4,5-b*]pyridine; PKC, protein kinase *c*; PROD, pentoxyersorufin-O-dealkylase; PSA, prostate-specific antigen; PTEN, phosphatase and tensin homologue; PTK, protein tyrosine kinase; QR, quinone reductase; RB, retinoblastoma; ROS, reactive oxygen species; STAT3, signal transducer and activator of transcription 3; TGF-β, transforming growth factor-β; TIMP1, tissue inhibitor of metalloproteinase 1; TPA, 12-*O*-tetradecanoylphorbol-13-acetate; uPA, urokinase plasminogen activator; VE, vascular endothelial cadherin; VEGF, vascular endothelial growth factor.

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