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Review

Target/signalling pathways of natural plant-derived radioprotective agents from treatment to potential candidates: A reverse thought on anti-tumour drugs

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ABSTRACT

Radiation damage can occur in nuclear power plant workers when physical protections fail, which results in nuclear leakage through the protective layers. Alternatively, workers may be unable to use physical protection in time (in the case of a sudden nuclear weapons attack). In addition, patients who receive local radiotherapy and are not allowed to adopt local physical protection may experience radiation damage. Thus, protection against chemical radiation has become indispensable. In view of the side effects caused by synthetic radioprotective agents (such as amisfostine), searching for radioprotective agents from plant sources is an alternative strategy. Radiation damage can cause multiple signalling pathway disturbances, leading to multiple organ injuries. Changes in these signalling pathways can lead to apoptosis, necrosis, and autophagy, as well as organ fibrosis, atrophy, and inflammation. Through literature searches, we determined that most targets for treating radiation injury are mechanistically opposite those of anti-tumour agents. This is likely attributable to the idea that anti-tumour agents promote cell necrosis or apoptosis, whereas the goal of anti-radiation agents is to promote cell survival or autophagy. This observation has important theoretical and practical significance when searching and developing new radioprotective agents derived from plant extracts. Further, it has important guiding value for meeting military needs and serving the public.

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Abbreviations: ABCA, ATP-binding cassette transporter; ARE, antioxidant response element; ATF, activating transcription factor 2; ATM, ataxia-telangiectasia mutated; ATR, ATM- and Rad3-related; CDKN, p53/p21/cyclin dependent kinase inhibitor; COX-2, cyclooxygenase-2; CREB, cAMP-responsive element binding protein; DDIT, DNA damage inducible transcript; DHF, 7,8-dihydroxyflavone; DSB, DNA double-strand break; EGF, epidermal growth factor; EPO, erythropoietin; ER, endoplasmic reticulum; ERCC1, nucleotide excision repair; GADD45A, growth arrest and DNA-inducible 45 alpha; GAPDH, glyceraldehyde 3-phosphate dehydrogenase; G-CSF, macrophage colony-stimulate factor; GPX, glutathione peroxidase; HIF, hypoxia inducible factor; HSP, heat shock protein; HO, heme oxygenase; HR, Homologous recombination; IGF, insulin-like growth factor; IL, interleukin; MAPK, mitogen-activated protein kinase; ICAM, intercellular adhesion molecule; JNK, c-Jun N-terminal kinase; MDM2, mouse double minute 2; MMP, matrix metalloproteinase; MPG, N-methylpurine DNA glycosylase; NBS1, Nijmegen breakage syndrome-1; NHEJ, nonhomologous end joining; NF-κB, nuclear factor kappa-B; Nrf2, NF-E2-related factor 2; OGG1, 8-oxoguanine-DNA glycosylase 1; PCNA, proliferating cell nuclear antigen; POLD, DNA polymerase delta; PUMA, p53/p53 upregulated modulator of apoptosis; RPA, 32-kDa subunit of replication protein A; ROS, reactive oxygen species; RTK, receptor tyrosine kinase; S1P, sphingosine 1-phosphate; SIRT1, sirtuin-1; SMO, smoothened; SOD, superoxide dismutase; STAT, signal transducer and activator of transcription; TDG, thymine DNA glycosylase; TGF-β, transforming growth factor beta; TNF-α, tumour necrosis factor alpha; TLR, toll-like receptor; TRAIL, TNF-related apoptosis inducing ligand; TrK, tropomyosin receptor kinase; TRP, transient receptor potential; TXN, thioredoxin; TXNRD, thioredoxin reductase; PARP-1, poly(ADP-ribose) polymerase; PPAR-γ, peroxisome proliferator-activated receptor gamma; UV, ultraviolet; VCAM, vascular cell adhesion molecule; VEGF, vascular endothelial growth factor; XIAP, x-linked inhibitor of apoptosis; XPA, xeroderma pigmentosum A; YAP, yes-associated.

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