Herbs in Radiation Protection

H C Goel

Defence Research & Development Organisation, Ministry of Defence, India

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Dr HC Goel
Director, Amity Centre for Radiation Biology
Amity University, Noida, UP
&
Scientist G (Retd.), INMAS, DRDO

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HC GOEL

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Preface

The necessity of writing the monograph 'Herbs in Radiation Protection' was realised since a large number of scientists are working in the area of radiation protection. Researchers have screened thousands and thousands of agents yet no clinically acceptable radio-protector is yet available.

The toxicity has been an important stumbling block which has kept the success story of radio-protectors elusive. In a cellular system, there are about two billion molecules, and cellular metabolic pathways are coordinated through extremely sensitive regulations. Environmental stimuli are responded to by a plethora of molecules within the cell, and strategy of alternate metabolic pathways is fully exploited to avert the environmental stress. The sea-saw between environmental stimuli and cellular responses ultimately reach a state that makes the cell either to apoptise, and necrotise or survive by adapting or annulling the environmental challenge. With increasing level of organisation from a cell to whole organism, the coordination and cybernetic control mechanisms get increasingly complex and intricate.

Whole body radiation exposure leads to multi-factorial events which may be dominated by few specific symptoms that combinely generate a syndrome depending upon the level of radiation exposure. Such syndromes are initiated by many events progressing concurrently and therefore, molecular drugs which influence only few metabolic pathways fail to provide the wholesome treatment to the radiation-induced pathology.

This scenario led to the application of combination modality involving many molecular drugs working with different modes of action. Unfortunately, this also could not appreciably enhance the radio-protective efficacy or reduce the toxicity substantially. This prompted the investigations using whole extracts of various medicinal plants. This was assumed that most of these plants have several kinds of biomolecules. A plant extract having hundreds of bioactive molecules is a natural combination that has been evolved by nature through evolutionary process over a long period and this should be in harmony with the animal systems which have also grown together in the same or specially characterised ecosystem. This sort of combination available in a plant could be expected to annul the important mechanisms of induction of radiation damages and help rapid recovery. An attempt has therefore been made to consolidate the results reported by different workers on different plants about these aspects in a simple and comprehensive manner.

In this multidisciplinary area of radiation protection, often the scientists belonging to different backgrounds undertake these studies. They are often not exposed to the

intricacies of radiation biology like oxidative damages, impairment of immune competence, inflammatory processes and damage to DNA, cessation of cell proliferation necessary to replenish depleted cells and the toxicity. It was therefore considered necessary to include brief write up on these aspects in part I of the monograph in a comprehensive form.

Part II of the monograph describes the potential herbs that can be exploited in the development of a radio-protector of clinical grade. This part of the monograph includes the information on radioactive and radiotherapeutic attributes of various medicinal plants available in the literature have been complied. For each plant included here, basic information like habit and habitat, geographical distributor, important phytochemicals, and exploration of their radio-modifying properties. Each plant extract has been included only if it was investigated as a singular agent and not in combination so that the effects were not confounded and remained simple to interpret.

A list of medicinally important phytochemicals has also been included here with the intention that it could provide easy reference about the availability of different kinds of biomolecules that may help in augmenting the efficacy of the extract.

It is expected that the information in the monograph may prove useful to scientists working in this area.

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Delhi — Dr HC Goel

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PART II

Introduction

The origin of the universe has been considered to be a consequence of events that followed a rapid outburst of immense energy transforming into matter with a big bang. As a consequence, elementary particles like photons, electrons, protons, and neutrons were generated and each particle has a definite quantum of energy. Interaction of these entities led to the creation of various combinations, the atoms of different kinds, which in turn generated molecules of various elements and compounds. Innumerable stars, galaxies and solar systems came into existence. The Sun, sometimes after its creation, dissociated some of its mass to generate various planets including Earth. It may be necessary to mention that all entities in the cosmos have been constantly revolving and everything in this universe has inherent energy and during various interactions the energy flows in or out of the system. This process results even in the birth of new stars and some stars get trapped and lost into the black holes. This dynamism is the core mechanism of the existence of this universe. Not only at macro level, even at the micro and most elementary level the generation and decay of atoms and molecules along with the absorption or release of energy keep on going in any celestial body. In fact atoms with high atomic mass are not very stable and keep decaying into lighter daughter nuclei and release some energy in the form of radiations. This is radioactivity and one of the natural sources of radiation energy.

Earth also came into existence when powerful explosion in the sun dissociated some of its red-hot mass which cooled down slowly over a period of time. The earth, being a planet keeps revolving around the sun. Since the earth originated from the sun, the physico-chemical characteristics of the matter of the two resemble closely. The surface of the cooled earth became a suitable ground for the origin of life. The simplest form of life that originated in water in presence of sunlight and grew more and more complex acquiring different forms through millions and millions of years. In this evolutionary march forward, life successfully trumpeted the survival meeting various challenges generated by the dynamic environment. Both plants and animals evolved divergently in various directions, many newer forms of life emerged and several were exterminated or became extinct. The sun, however, remained at the centre-stage supporting life on this planet. In the Sun, nuclear reactions keep going continuously releasing vast amount of energy in the form of heat and radiations that constitute a major source of energy for the survival of life on earth.

The earth, being a product of the sun, also keeps emitting radionuclei and radiations on the surface in very small quantities; however at certain places on the earth the radiation flux is relatively high. The sunlight provides heat and energy for photosynthesis that is responsible for the existence of primary producers on which can sustain the secondary producers and the consumers, the animal world.

Important biological activities of all the living systems are dependent on light; the circadian rhythms, the nocturnal and diurnal behaviour, the growth, flowering, fruiting and seed ripening are all regulated in a major way by radiant energy of the sun. The mutations in the genome of living systems caused by background radiations have been the major source of organic evolution on this planet. Radio waves are similarly necessary for communication. It appears that most of the radiation energy is necessary for life and living systems have learnt to live with radiations.

There are various kinds of radiations having different energies and characteristics. In limited quantities the radiations are harmless as described above. However, there are high energy or ionizing radiations, which are not so harmless. The energy associated with these radiations is enough to cause perturbation in the configuration of biomolecules. The harmful effects may not be apparent immediately but may be manifested at a later date depending on the magnitude of exposure. Very low doses of radiations may be hormetic and adaptive. The description, mechanisms and explanation of these effects, lethal or non-lethal, acute or delayed, gross or microscopic, can provide leads for the development of useful applications of radiation in research, agriculture and medicine. Development of devices for exploiting vast energy stored in the atom for strategic and tactical purposes in the last century and the geo-political ambitions of certain nations in the recent past have catalysed the emergence of several nations with nuclear capabilities. In the recent times various national and international terrorist outfits have also emerged claiming nuclear capabilities. The diminishing reserves of fossil fuel and increasing demand of energy for development by human society has warranted the harnessing of nuclear energy for peaceful purposes. The ever-increasing use of nuclear energy has also necessitated the development of safety devices and protective strategies from both physical and biological point of view. In the present monograph the endeavour has been made to focus on various strategies developed for biological radio-protection and the potential of the application of herbal products in this context.

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About the Author

Dr HC Goel, Director, Amity Center for Radiation Biology & Amity Institute of Nuclear Science and Technology, Amity University, did his post-graduation in Zoology from Agra University in 1964 and immediately thereafter, joined as a faculty for post-graduate and graduate classes. In 1968, he joined Defence Research and Development Organisation (DRDO), Ministry of Defence, till his retirement in 2003 as Scientist G. In DRDO, he worked at Defence Research and Development Establishment (DRDE), Gwalior and Defence Institute of Physiology and Allied Science (DIPAS), Delhi, for few years and has mainly been at Institute of Nuclear Medicine and Allied Sciences (INMAS), DRDO, Delhi, as Head, Radiation Biology Division. He has worked on various aspects of radiation injuries, radiation carcinogenesis, radio-modifiers, and biological dosimetry for assessment of radiation exposure. His is keenly interested in the study of medicinal herbs for radioprotective and radiotherapeutic purposes. On these aspects he published about two dozen research papers in various journals of repute and also contributed chapters in several books and monographs .'He has also edited few proceedings of International Conferences.'

About the Book

The book has two parts. Part I describes the basic concepts about radiations, their interaction with matter and especially bio-molecules, mechanisms of radiation injuries at tissue and higher levels of organisation. For a non-radiobiologist, this information should prove handy and comprehensive. Part II describes radioprotective and radiotherapeutic attributes of different plants as reported in the literature. A list of important phytochemicals available in the plant kingdom has also been included. Description about each plant includes¬—habitat, geographical distribution, and phytochemicals as reported in the literature. The application of each plant for treating various ailments described in '*Charak Samhita*' and scientific literature has also been enumerated. The list of various phytochemicals and chemical constituents of each plant can give a wide scope to researchers in the field of radioprotections for developing various combinations to achieve high efficacy for radioprotection and radiotherapeutic modification.

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