Gamma Radiation Induced Degradation of Endosulphan in Water

Hasan M. Khan\textsuperscript{a}, Noor S. Shah\textsuperscript{a}, Ikram ul Haq\textsuperscript{b} and Saifullah\textsuperscript{b}

\textit{a) Radiation Chemistry Laboratory, National Centre of Excellence in Physical Chemistry, University of Peshawar, Peshawar 25120, Pakistan.}
\textit{b) KPK University of Agriculture, Peshawar 25120. Pakistan}
\texttt{hmkhan@upesh.edu.pk}

Water contamination due to organic pollutants, like chlorinated pesticides, is a global environmental problem. Endosulphan is one of these chlorinated pesticides that have contaminated water, soil and air samples of the environment in many regions of the world, including Pakistan. It is photostable and persists for long time in various environmental matrices, like water. Various techniques, such as air filtration, biodegradation and advance oxidation techniques e.g. photocatalytic, UV/H\textsubscript{2}O\textsubscript{2} and gamma radiation can be used for the removal of endosulphan from water. Out of all these techniques, gamma irradiation has shown promising results and this is also environmentally friendly. Standard endosulphan solution (350 ppb) in ultrapure water was irradiated using gamma irradiation from a $^{60}$Co gamma rays source in the Nuclear Institute of Food and Agriculture (NIFA) Tarnab, Peshawar for different doses from 150 Gy to 1020 Gy corresponding to different time. The irradiated and non-irradiated samples were analyzed using solid phase microextraction (SPME) fiber followed by gas chromatography with electron capture detector (GC-ECD) using HP5 column. The effect of various radical scavengers, like isopropanol, tertiary butanol, nitrate, carbonate and bicarbonate were carried out on the radiolytic degradation of endosulphan. It was found out from the detailed study that radiolytic degradation of endosulphan is greatly affected because of these radical scavengers. Kinetic study of the radiolytic degradation of endosulphan in water as well as in presence of radical scavengers were carried out and was found to be pseudo-first order. The percent degradation, chemical radiation yield (G-value) and dose constant (k) were determined. The percent degradation was found to increase with the increase in dose. By-products determination was carried out using GC-ECD and ion chromatography (IC). The major products were endosulphan lactones, acetic acid and chlorides. The possible degradation mechanism will be discussed in detail.