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Current Concerns on Genotoxicity of Pesticides

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Regarding the huge amount of pesticides and their use in the environment, it would not be surprising to state that we are living in a contaminated toxic world. Pesticides have the capacity to accumulate in the environment and enter human food cycle through food, water or the air. Although these agents are toxic but their use is inevitable of today's life because they control pests and vectors of diseases. The pesticides are from different classes of chemicals having several active ingredients that are currently marketed in multiple formulations and used as insecticide, herbicide, or fungicide. Nonetheless, rise of the need for food and the pest resistance moreover stimulates agrochemical industry to produce new and more efficient pesticides which in turn potentiate ubiquitous human exposures arising from occupational or environmental contaminations (Mostafalou and Abdollahi, 2012). The consequence of high use of pesticides in the environment is a wide spectrum of toxicological effects on the nervous, immune, cardiovascular, respiratory and reproductive system and even cancer that are mainly related to potential of pesticides in creating oxidative stress (Abdollahi *et al*., 2004). The history of the link between agrochemical exposures and cancer is referred to a report in 1958 giving that European farmers using insecticides in grape production had an elevated rate of skin and lung cancer (Eastmond and Balakrishnan, 2010). This and other primary reports were presented when the molecular genetics was growing during the years 1953-1968 that allowed scientists to increasingly study on pesticide exposure in a new field called genetic toxicology. Indeed, genotoxicity is defined as the ability of inducing genetic damage and considered as a primary risk factor for chronic diseases within the context of carcinogenesis and teratogenesis. Growing body of data concerning genetic toxicity of pesticides has been collected from different kinds of cytogenic examinations including chromosomal aberrations, micronucleus, sister chromatid exchanges and comet assay. Several mechanisms have been proposed for genotoxicity of pesticides but among them, increased production of free radicals and DNA damage play the main role (Pournourmohammadi and Abdollahi, 2011; Shadnia *et al*., 2005). Currently, international agencies like Environmental Protection Agency of USA have classified more than 56 pesticides as carcinogen to laboratory animals with sufficient evidence. In this regard, some of pesticides like chlordecone, pentachlorophenol, DDT and some others have been banned or remained with restricted use in some countries (www.epa.gov). Nevertheless, witnessing data collected from post-market monitoring studies have not disclaimed the genotoxic risk of permitted pesticides used widely. Sometimes these reports were argued over their uncertainty because of difficulties in extrapolating data from experiments to the exposed population or complexity of epidemiological studies like poorly defined exposing pesticide or exposure levels as well as small study population, but genetic hazard of pesticides has not been rejected at all and even has received much more attention since genetic damages interfere in diseases whose etiology and treatment have been partly remained as an unsolved mystery of medical sciences (Bull *et al*., 2006). Moreover, the issue of pesticide genotoxicity is no more limited to occupational exposure for which some preventive approaches have been already presented including factory guidelines for people who work in the field of producing, farming, spraying and other application. Considering pesticides as residues entering food chain and living environment of all people, the global threat is growing. Although, the exposed level of general population to a single pesticide by this mean is very low, long-lasting exposures to low doses of mixtures of pesticides can potentiate their cumulative genotoxic activities (Graillot *et al*., 2012; Karami-Mohajeri and Abdollahi, 2011). Since available data in this respect is inadequate, post-market monitoring studies, when designed appropriately are valuable tools to continue evaluation of genotoxic risk of pesticide residues and provide proper platforms to substantiate pre-market assessments. However, according to vitality of the issue, time to find and apply new approaches for lowering the risks is passing and it should not be fair to delay late by just waiting for more evidence or proof. Overall, educational programs for formulators and farmers in order to implement good protection measures, in

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addition to proper application of pesticides and agricultural practice aiming to decrease use of agrochemicals and subsequent reduction of their residues' limit in foods are of considerable value to prevent genotoxic effect of pesticides coming from occupational and environmental exposures. By analogy to experimental studies pointing determinant role of oxidative stress in both genetic damage and pesticides' toxicity, administration of preventive agents having antioxidant capacity might help to reduce the risk (Soltaninejad and Abdollahi, 2009) and even protect from common consequences like diabetes (Hosseini and Abdollahi, 2012) though it still needs further investigations.

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