Chlorpyrifos for Pistachio Pest Control and its Effects on Human Health

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Pistachio (*Pistaciavera L.*), one of the most significant agricultural products, plays a prominent role in world trade markets [1]. The pre-eminent countries active in the production and export of pistachios include Iran, the United States, China, Turkey, and Syria [2].

Using chemical fertilizers and pesticides in pistachio production and consumption to control pests and increase the productivity of this agricultural product is a matter of grave concern [3, 4]. One of the pests that have very detrimental and damaging effects on the quantity and quality of the pistachio tree is pistachio psylla (*psylla pistaciae*) (*Homoptera: Psyllidae*) [5]. As a result, various chemical pesticides are applied to manage this pest. The most widely used group of pesticides is organophosphates (OP) pesticides such as diazinon and chlorpyrifos (with different brands such as Dursban, Lorsban, Empire20, Equity, and Whitmire PT270) [6, 7]. 14,000 tons of agricultural pesticides are used in Iran annually, a number that is increasing as the pests become more and more resistant to these pesticides [8, 9].

Chlorpyrifos is one of the most widely used organophosphate pesticides to control agricultural pests in the world [10, 11]. Chlorpyrifos toxin has toxic effects on humans, and its use is banned for raw agricultural products such as vegetables and fruits. However, due to its wide range of applications and high efficiency, it has not been withdrawn from the market, still being applied by farmers synthesized with other toxins to manage pistachio psyllid pest [6, 12].

One of the most serious concerns in the consumption of agricultural products, especially pistachios, is that they contain residual organophosphate toxins, especially chlorpyrifos, due to the accumulation in the fruit and kernel of this product [13, 14]. Studies confirm the occurrence of chlorpyrifos pesticide residues in food products, fruits, vegetables, and pistachio kernels [7, 13, 15, 16], as well as skin exposure and skin absorption among farmers [6, 12].

Some of the most harmful consequences of exposure to chlorpyrifos toxin through foods and drinks are as follows: inhibition of acetylcholinesterase (AChE) activity in the central nervous system (which plays the role of hydrolysis of acetylcholine or neurotransmitter) [12]; neurotoxic effects; cardiotoxicity and hepatotoxicity of tissues [7]; increased risk of various cancers; neurodevelopmental disorders, and other chronic diseases [17]. Codex Food is an international organization that determines the maximum residue limits (MRL) in food products. For pistachio, the MRL for pesticides is generally 0.05 µg per gram of pistachio kernel [13]. Chlorpyrifos MRLs are also 0.003 mg per kg body weight per day based on daily intake [6].

Finally, the key factor in the retention of pesticides in agricultural products is pre-harvest intervals (PHI), the minimum amount of time between the application of pesticides the crop can be harvested. Following this principle leads to a considerable reduction in the retention of pesticides in food products [13]. Other ways to reduce farmers' pesticide exposure through food consumption, especially pistachio kernels, include washing, peeling, cooking, and drying, especially by sun exposure [13].

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