



The Use of Pesticides in Food Production and their Impacts in Public Health

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With the increasing population growth, the demand for agricultural production has increased considerably in recent decades. The model used by the agricultural sectors to increase this productivity, in most developed or developing countries, involves monocultures, transgenics, and intensified use of agrochemicals. However, this *modus operandi* has generated substantial social and public health impacts, especially regarding the intensive use of agrochemicals.

Pesticides, also known as phytosanitary products, agricultural pesticides or agrochemicals, are toxic chemicals; they include herbicides, insecticides, acaricides, fungicides, nematocides, and rodenticides. As active ingredients, pesticides have chemical compounds formulated to increase productive potential through the prevention, combat or destruction of undesirable species or diseases that can interfere in the processing, storage, and transportation of food and agricultural products.

The indiscriminate use of pesticides has become a matter of increasing concern since it results in the contamination of different environmental compartments, even those far from the places where these agrochemicals are applied directly. Abiotic factors of the environment including rains, winds, and erosions, in addition to the biomagnification of these compounds via the food chain - especially those of high persistence such as organochlorines - facilitate reaching of non-target organisms by pesticides, including humans. Severe damage to biodiversity and human health is imminent and are intensely increasing. However, these environmental impacts allied to health and social impacts are not

incorporated into the cost of the agro-production chain; instead, they paid by society through public spending and, even worse, they eventually result in diseases and deaths that could be avoided.

Reports of pesticide poisoning are numerous and have a direct impact not only on the farm workers' health but also on consumers of contaminated food and water. Each class of pesticide can lead to different effects on human health, depending on its form and time of exposure. Since each product has its specific toxicity, the most different toxicological effects can be observed. Among the most commonly used pesticides are the organophosphates (OF) and carbamates, organochlorines, pyrethroids, and triazine derivatives.

OFs are the most used compounds as pesticides worldwide. Their action mechanism is the phosphorylation of the acetylcholinesterase (AChE); by blocking this enzyme, the acetylcholine (ACh) neurotransmitter accumulates in the synapses, which leads to increased stimulation of the effector organ. This increase results in signs and symptoms of muscarinic and nicotinic action, including miosis; tearing; excessive salivation; changes in visual acuity; cardiac manifestations; tremors; paralysis; convulsions, and neurological changes such as muscle weakness, which can lead to respiratory failure and even death. The clinical picture due to OF poisoning can develop at three stages: firstly, the acute cholinergic syndrome, followed by the intermediate syndrome, and finally late neuropathy.

Like the OFs, carbamates are AChE inhibitors; and their action mechanism is to prevent acetylcholine inactivation through enzyme carbamylation reversibly. This process leads to a more prolonged action on muscarinic and nicotinic receptors.

Their persistence in the environment characterizes organochlorines, and so they have been banned in several countries. Because they are liposoluble, they accumulate in the adipose tissue of organisms. Through the food chain, organochlorines can be transported to the most remote parts of the planet, like Antarctica and the Arctic. The results for the species that occupy the top of the food chain are disastrous, including humans. These substances can be introduced into the body through the respiratory, cutaneous and digestive tract. Among its effects, the following are included: processes of endocrine disruption that alter estrogenic and testosterone activities; induction of genotoxic processes with the appearance of neoplasms in organs of the digestive system, lung, and kidney; hepatic and renal damage; immunosuppressive and neurotoxic activity, including Parkinson's disease.

Pyrethroid insecticides are widely used in agriculture, as well as in the domestic environment and public health campaigns. These pesticides cause hypersensitivity and allergies; Also, some compounds, such as the cypermethrin, are mutagenic and genotoxic.

Acute pesticide poisonings, most often related to occupational exposure, can lead to death. However, chronic intoxications are no less severe; they are characterized by the late onset of symptoms after months or years of moderate exposure to single or multiple toxic products, and thus irreversible damage can occur to exposed individuals.

Exposure from food intake with pesticide residues is also considerable, and monitoring programs for residues in foods, especially fruits and vegetables, should be encouraged as the technology provides chromatographic equipment and mass spectrometers capable of detecting residues at ultra low levels.

Unrestrained use of different classes of pesticides is an impending danger to the environment and human health. The effects of the mixtures of many of these compounds in the organisms are not yet known. Therefore, public policies that regulate their conscious use by involving multiple areas of knowledge, especially the interface between toxicology and pharmacology, are increasingly necessary.

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