

# Existence of Insecticides in Tap Drinking Surface and Ground Water in Dakahlyia Governorate, Egypt in 2011

RA Mandour

## Abstract

**Background:** The environmental degradation products of pesticides may enter drinking water and result in serious health problems.

**Objective:** To evaluate the occurrence of insecticides in drinking surface and ground water in Dakahlyia Governorate, northern Egypt in 2011.

**Methods:** We studied blood samples collected from 36 consecutive patients diagnosed with pesticides poisoning and 36 tap drinking water (surface and ground). Blood and water samples were analyzed for pesticides using gas chromatography-electron captured detector (GC-ECD). In addition, blood samples were analyzed for plasma pseudo-cholinesterase level (PChE) and red blood cells acetyl cholinesterase activity (AChE).

**Results:** The results confirmed the presence of high concentrations of insecticides, including organonitrogenous and organochlorine in tap drinking surface and ground water.

**Conclusion:** Drinking water contaminated with insecticides constitutes an important health concern in Dakahlyia governorate, Egypt.

**Keywords:** Diffuse pollution; Pesticides; Human health

## Introduction

The World Health Organization (WHO) estimates that approximately three million pesticide poisonings occur annually worldwide that cause more than 220 000 deaths.<sup>1</sup> More acutely toxic pesticides have been used for suicide and murder.<sup>2</sup> Ninety-five percent of fatal pesticide poisonings occur in developing countries. It is recognized that the environmental degradation products of pesticides may enter drinking water and cause serious health problems.<sup>3,4</sup>

Acute poisoning with pesticides is common; it usually occurs due to careless use or misuse of pesticides or occupational exposure to them.<sup>5</sup>

Pesticides are classified into four groups: insecticides, herbicides, rodenticides and fungicides. Special attention has been given to insecticides since they are the most common poisoning substances affecting our population. According to WHO, the presence of toxic pollutants in water especially insecticides can change the quality of surface water.<sup>6</sup> They enter surface and ground water primarily

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Toxicology Unit,  
Emergency Hospital,  
Mansoura University,  
Egypt



Correspondence to  
Raafat A. Mandour  
Toxicology Unit,  
Emergency Hospital,  
Mansoura University,  
Mansoura 35516,  
Egypt  
Tel: +2-012-526-0108  
E-mail: mandourraafat@yahoo.com  
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**TAKE-HOME MESSAGE**

- In some developing countries, some toxic pesticides are used for suicide and murder.
- Environmental degradation products of pesticides may enter drinking water and cause serious health problems.
- Pesticide induces serious health problem not only in people who applying pesticides but also in other people.
- It seems that contamination of the tested wells was due to pesticides and not wastewater disposal.
- This contamination is mainly due to the uncontrolled industrial and agricultural activity as well as lack of an appropriate monitoring system.

as runoff from crops and are most prevalent in agricultural areas. The exposure to insecticides through a pollutant drinking water represents a rare source of exposure among other different sources including agriculture, industrial and domestic purposes.<sup>7</sup>

Dakahlyia Governorate is a region in North of Egypt, lying between latitudes 30° 30' and 31° 30' N and longitudes 31° 15' and 32° 00' E. It is characterized by a gentle slope to the North. The drinking water resources in the governorate comprise surface and ground waters. The main surface water is the River Nile flowing in Damietta branch and its distributaries irrigation canals. The southern part of governorate is supplied by ground water (Mit-Ghamr, Aga and el-Sinbillawin); the rest of the governorate is supplied by regional and municipal systems which

rely on surface water. Previously, we have reported on levels of some heavy metals in surface and ground water in this region.<sup>8,9</sup> This study was conducted to evaluate the occurrence of insecticides in tap drinking surface and ground water and related health issues in this region in 2011.

**Materials and Methods****Blood Samples**

Blood samples were collected from 36 patients diagnosed with pesticides poisoning (34 accidental and 2 suicidal attempts). Patients were presented with signs and symptoms of poisoning with cholinesterase inhibitor insecticides including variable degrees of sweating, diarrhea, nausea, vomiting, weakness, breathing problems, hyperirritability and extreme anxiety.

**Water Samples**

Thirty-six water samples were collected from the residence of the same patients at two different times—August 2011 (summer), after the application of pesticides; and October 2011 (autumn), during the first seasonal rainfalls (Fig 1). To assess spatial variation in terms of contamination by pesticides, surface water samples were also collected from different sites of the Governorate, especially from houses near agricultural fields. To assess potential ground water contamination, samples were also taken from wells near drainage system.

**Analytical Methods**

Blood and water samples were analyzed for pesticides using gas chromatography-electron captured detector (GC-ECD). In addition, blood samples were analyzed for plasma pseudo-cholinesterase level (PChE) by spectrophotometer according to Ellman, *et al*,<sup>10</sup> and red blood cells ace-

For more information on the level of heavy metal in surface and ground water see [www.thejjoem.com/ijoen/index.php/ijoen/article/view/80](http://www.thejjoem.com/ijoen/index.php/ijoen/article/view/80), and [www.thejjoem.com/ijoen/index.php/ijoen/article/view/81](http://www.thejjoem.com/ijoen/index.php/ijoen/article/view/81).

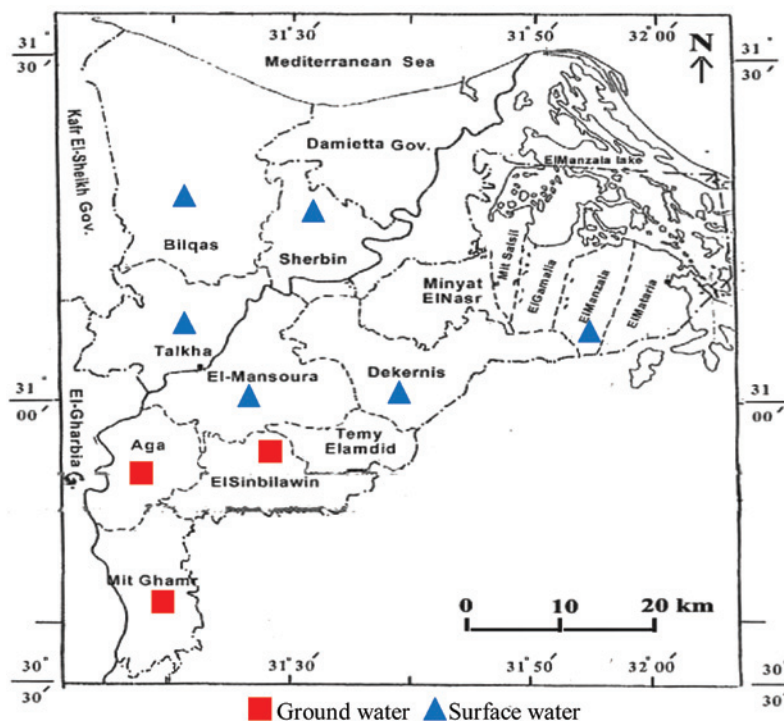
tyl-cholinesterase activity (AChE) according to Crane, *et al.*<sup>11</sup>

## Results

Of 36 patients studied, 25 (69%) had moderate pesticides poisoning (AChE activity 500–1000 U/L), 9 (25%) had severe poisoning (AChE activity <500 U/L), and 2 (6%) had mild poisoning (AChE activity >1000 U/L). The analyzed drinking water and blood samples contained organonitrogenous insecticides; aldicarb [2-methyl-2(methylthio)propionaldehyde O-(methylcarbamoyl)oxime] of molecular weight 190 and chemical formula (C<sub>7</sub>H<sub>14</sub>N<sub>2</sub>O<sub>2</sub>S) and organochlorine insecticides—DDT (dichlorodiphenyl trichloroethane) of molecular weight 342 and chemical formula (C<sub>14</sub>H<sub>9</sub>Cl<sub>5</sub>). The characteristic mass spectra of fragment ions are 86, 58, 144 for Aldicarb and 235, 165 m/z for DDT.

## Discussion

People applying pesticides working in farms of Egypt are at risk of developing serious health problems.<sup>12</sup> It seems that this health problem is not limited to them and other people are also at risk. Examination by GC-ECD indicated that drinking water (surface and ground) and blood samples contained organonitrogenous insecticides; aldicarb and organochlorine insecticides—DDT. These contaminations were not due to any treatments given in drinking water stations or houses. Presence of aldicarb is similar to reports from Canada and USA where it was detected in 111 of 1017 studied samples in surveys of private and municipal drinking water (surface) supplies in Canada<sup>13</sup> and in well-water in the USA<sup>14</sup>. DDT and its metabolites were found in some water network (rivers) during 1979–84 according to a report by the Global Environmental



**Figure 1:** Sites of water sampling in Dakahlia Governorate

Monitoring System (GEMS). We detected residues of pesticides in both sampling periods (summer and autumn), especially in autumn when rainfall promoted the runoff and leaching of pesticides from the nearby agricultural fields to the aquatic system. The concentration of aldicarb in water samples taken from all surface sampling sites, in both sampling periods, exceeded the water quality value (WQV) for protection of freshwater species.<sup>15</sup> Ghanem, *et al*, reported that the concentration of pesticides in Jenin was higher than that in Tulkarem.<sup>16</sup>

We believe that the contamination of the tested wells was due to pesticides and not wastewater disposal, since most of the samples were free from pathogenic indicators. Using these wells for drinking purposes carries a potentially high health risk. This is mainly due to the uncontrolled industrial and agricultural activity as well as lack of an appropriate monitor-

For more information on clinical and biochemical parameters of children and adolescents applying pesticides see [www.theijoem.com/ijoem/index.php/ijoem/article/view/41](http://www.theijoem.com/ijoem/index.php/ijoem/article/view/41).

ing system. These pesticides exert their primary and acute toxic effect by inhibiting AChE.<sup>17</sup> A 60% reduction in cholinesterase activity can produce relatively mild nonspecific symptoms such as vertigo, nausea, anxiety, vomiting, diarrhea, asthma-like tightness of the chest, increased sweating, increased salivation, wheezing and shortness of breath, myosis, and malaise.<sup>18</sup> More inhibition of cholinesterase activity may produce pulmonary edema, unconsciousness, respiratory failure, and even death.<sup>19</sup>

Aldicarb is a systematic carbamate insecticide used to control insects on a wide variety of crops, very persistent in ground water, particularly those that are acidic.<sup>14</sup> Concentrations in ground water near potato fields to which it had been applied were detected in 31.3% of samples taken.<sup>20</sup> Aldicarb is one of the most acutely toxic pesticides in use, although the only consistently observed toxic effect with both long-term and single-dose administration is AChE inhibition.<sup>21</sup> Clinical symptoms of aldicarb intoxication is mainly those of AChE inhibitors and include dizziness, weakness, diarrhea, nausea, vomiting, abdominal pain, blurred vision, temporary paralysis and dyspnea but recovery is rapid within six hours.<sup>22</sup> The effects of chronic ingestion of aldicarb on human immune function were investigated in two limited cross-sectional studies on women.<sup>23</sup> One of them is attributed to presence of aldicarb in drinking water where an association was found between consumption of aldicarb in drinking water and abnormalities in various subsets of T-cell populations in women with otherwise intact immune systems.<sup>24</sup> The study revealed that changes in the cellular distribution of immune system parameters occurred in women exposed to aldicarb in their drinking water. A significant association between the age-adjusted rates for all neurological syndromes and increas-

ing aldicarb concentration was found in another study on the relationship between levels of aldicarb in drinking water and delayed neuropathy.<sup>25</sup>

DDT is a nonsystematic contact insecticide with a broad spectrum of activity.<sup>26</sup> If it does find its way into water, it is gradually lost by adsorption on to surfaces.<sup>27</sup> Signs and symptoms reported following acute intoxication by DDT include nausea, vomiting, dizziness, confusion and in severe cases, convulsions.<sup>26</sup>

Drinking water in Dakahlyia Governorate was contaminated with organonitrogenous, aldicarb and organochlorine insecticides, and DDT. The same chemicals were also detected in blood of patients presented with signs and symptoms of poisoning in this region. Presence of these pollutants in surface drinking water of the studied area has serious effects on human health. We therefore present the following suggestions:

Development efforts are critically needed in behavior correction on dealing with insecticides, in safety devices, availability of free first aid measures, and in assessment of workers in the insecticides field by multiple monitoring of them by cholinesterase levels (pre- and post-exposure) and removal of the workers from the work and not return until the enzyme level returns to 80% of the baseline.

Insecticides must be kept out of the reach and sight of children and never be stored in food or beverage containers.

On the other hand, we must pay attention to the magnitude of suicide problem by pesticides use. There must be a limitation in easy access of pesticides purchase to anyone.

Psychiatric assessment and follow-up of these patients are of worthy value in reducing this problem.

**Conflicts of Interest:** None declared.

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A mason at work carving stone (Photo courtesy of Marjan Bayat Maku, Shiraz). These workers are at risk of inhalational lung disease. For an article on inhalational lung disease see *The International Journal of Occupational and Environmental Medicine* 2010;1:29-38 (Available from [www.theijoem.com/ijoem/index.php/ijoem/article/view/4](http://www.theijoem.com/ijoem/index.php/ijoem/article/view/4))