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# Presence of Pesticide Residues in Drinking Water

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**Abstract**

*This article analyses the 90-day traceability of phosphate ion concentration in swamp water used for human consumption and fish farming in the department of Sucre. The results obtained were compared with the alert and maximum values indicated in resolution 2115 of 2007 issued by the Ministry of social protection, Ministry of environment, housing and territorial development. According to the values established in Resolution 2115-2007, the phosphorus values found in the form of phosphate in the marsh water intended for human consumption and fish farming activity is above the established levels, presenting a risk to human health, so early warnings and permanent monitoring should be established as indicators of contamination in the marsh.*

***Keywords:*** *Pesticide Residues, Drinking Water, farming*.

## INTRODUCTION

According to the National Plan for Municipal Wastewater Management in Colombia, there is a deficit of approximately 80% in the treatment and disposal of wastewater generated by agriculture, industry and domestic wastewater, which has generated significant accumulated pollution in various ecosystems, affecting their integrity and causing problems of health and physical, chemical and microbiological water quality in several regions.

The intensive use of pesticides in modern agriculture inevitably leads to agrochemical residues being translocated and absorbed into environmental compartments: water, air and soil. In general, these residues degrade slowly, which is why they are widely distributed in the environment, and even when present at low levels, they can cause harm to human health, due to their toxic, carcinogenic, mutagenic and teratogenic nature (Bogdanffy, et al., 2000; Kettles and Kruse, 2001; Rakitsky et al., 2000; Bell et al., 2001).

Acute organophosphate poisoning is a public health problem, as these products are currently widely used as pesticides in agricultural areas, causing the death of hundreds of people per year due to occupational, accidental or intentional exposure, being voluntary oral ingestion the most common; and accidental inhalation recorded in workers; mostly agricultural workers due to the inadequate use of protective equipment such as clothing and machinery for the performance of these tasks. Organophosphates have been used worldwide for the last 50 years as pesticides for pest management which could affect

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foodstuffs as they are well known for their high toxicity, slow degradation and bioaccumulation.

Globally, it is estimated that approximately more than three million people are exposed to these substances annually, of which one million from accidental causes and two million from suicidal poisoning with an estimated three hundred thousand deaths (Chowdhary et al., 2014). In the United States, eight thousand exposures were reported and of these fifteen deaths (Bird, 2018). In India, twenty-five thousand two hundred and eighty-eight cases of suicide deaths from its use were reported (Slavica et al., 2018).

In addition, the World Health Organization (WHO) reports twenty-six million deaths annually in countries in Southeast Asia, China and the Western Pacific (Slavica et al., 2018). Experts estimate that poisonings with these pesticides cause more deaths when compared to other classes of drugs or chemicals, estimating a fatality rate of 10% to 20%, and those surviving with difficult to manage morbidity (King et al., 2015).

A study reported by the Corporación de la Mojana that evaluated the ICA of surface water bodies within its jurisdiction, led by researchers working in the area of toxicology at the University of Córdoba, focused on water as an articulating system of environmental management to ensure a sustainable national system of water resources, which specifically referred to the results of the condition of the Ciénaga de San Benito Abad as demonstrating that the water body is contaminated.

The low levels of control and prevention of continuous and accumulated pollution of water resources in the region, as well as the permanent structural deficiency that does not allow the development, application and/or adoption of technologies for an effective and sustainable solution of strategic ecosystems, in addition to the lack of knowledge of the long-term impacts of these processes, are some of the major factors that influence the acute deterioration of one of the most important ecosystems in the country, given the supply and key environmental services for national water regulation, biodiversity and the survival of their populations (Jayara, et al., 2016).

There is great concern in society and worldwide, so in several countries there is restrictive legislation developed with the aim of preserving natural resources and human health. The United States Environmental Protection Agency (EPA-USA) considers a set of guidelines that aim to control pesticides with high water pollution potential (National Environment Agency, 2008). They have verified the risks posed by pesticides to human health and the environment, and have also established permissible concentration levels (MCLs) for toxic contaminants in surface water and water for human consumption. Other institutions such as the World Health Organization (WHO) and the European Union (EU), based on the primary criterion of preserving human health, have established maximum limits and restrictions for the different substances that contaminate water for human consumption (WHO - World Health Organization, 2004; Fielding, 1998). In the case of the EU countries, they are obliged by the Drinking Water Directive to comply with the limits established for pesticides, where the limit value for an individual pesticide is 0.1 µg/L and for the total of pesticides present is 0.5 µg/L, regardless of the nature of the pesticides (Fielding, 1998).

Under the aforementioned premise, the strategy was to carry out the traceability of the presence of phosphate ion in the water of the San Benito Abad marsh, used for human consumption and fish farming in the department of Sucre, over various periods of time.

## MATERIALS AND METHODS

Identification of the study area. The identification of the study area will be based on the preliminary diagnosis of water bodies contaminated with organophosphate pesticides in the department of Sucre.

Water sampling. The selected marsh will be traced back to the pesticide in the form of a phosphorus compound. Water samples for chemical quality analysis will be taken at seven different times (0, 15, 30, 45, 60, 75 and 90 days). The samples will be taken, preserved, stored and transported according to the protocol established by a specialized and certified laboratory in Colombia.

Chemical analysis of organophosphorus pesticide. Measurement of organophosphorus pesticides will be carried out by means of Gas Chromatography methodology - Florisil cleaning, in a certified laboratory in compliance with Decree 1594 of 1984 and Decree 901 of 1997.

Analysis of results. Traceability of phosphate ion in the water body will be carried out every 15 days for a total period of 90 days. The results obtained for the presence of phosphorus in the form of phosphate (mg PO4/L) will evaluate the concentration found with the permitted concentration in accordance with the provisions of the MINISTRY OF SOCIAL PROTECTION MINISTRY OF ENVIRONMENT, HOUSING AND TERRITORIAL DEVELOPMENT RESOLUTION NUMBER 2115 OF 22 JUN 2007. Likewise, the percentage of accumulation in each period of time analyzed will be carried out and the initial concentration will be taken as the permitted concentration in accordance with the provisions of ARTICLE 7.- Chemical characteristics that have economic and indirect consequences on human health. The chemical characteristics of water for human consumption in relation to the elements and chemical compounds that have economic and indirect consequences on health are indicated below (Resolution No. 2115 DE 2007).

## RESULTDS AND DISCUSSION

Figure 1 shows the concentration of P-P04 in mg/L in swamp water used for human consumption and fish production. On day 1 the concentration found was 1.35 P-P04 mg/L, on day 4 (45th day) it increased to 1.67 P-P04 mg/L and on day 7 (90th day) it was 1.87 P-P04 mg/L. According to the results obtained, it can be observed that the concentration of the compound is increasing as the days go by.

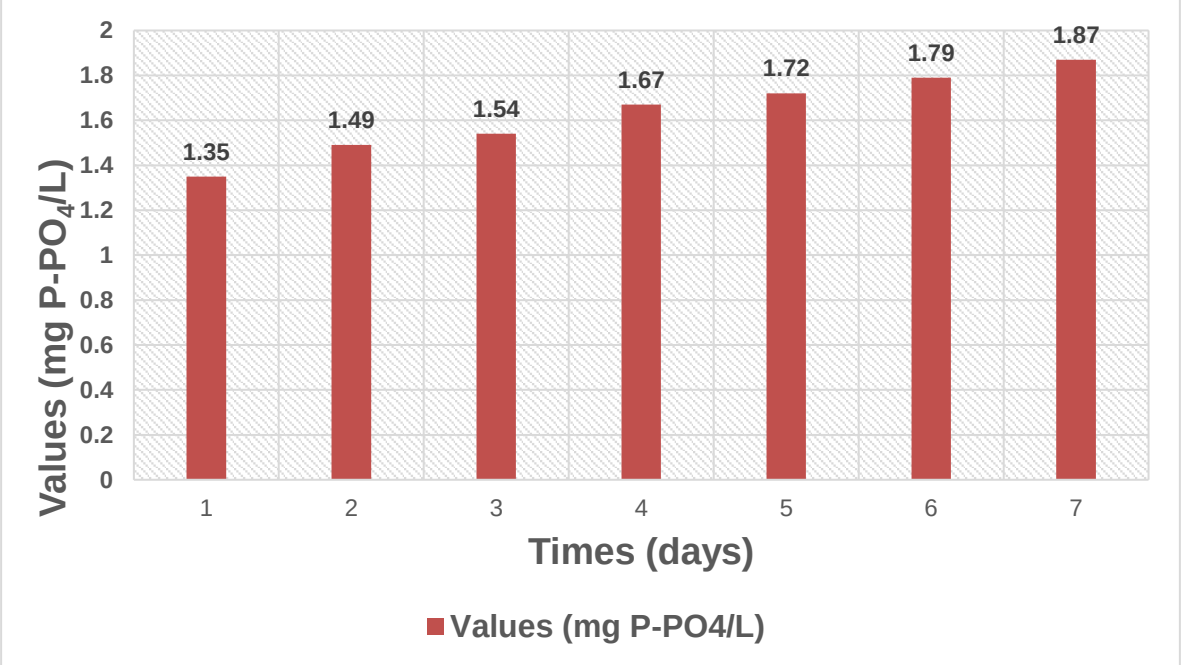


Figure 1. Phosphate concentration in marsh water in the department of Sucre.

The Colombian standard establishes limits for the soluble phosphorus species and not for the total phosphorus species. According to the Colombian Standard Resolution 2115 of 2007, in article 7. Chemical characteristics that have economic and indirect consequences on human health establishes that the acceptable value for the concentration of phosphates in water for human consumption (drinking water) must be less than or equal to 0.5 mg/L of $PO^{-}_{3}$. There is no Colombian standard for total phosphorus. As a reference related to the magnitude of phosphate ($PO_4$), Directive 75/440/EEC of the European Union was considered, whose permissible limits for surface water intended for human consumption according to the type of treatment required are 0.52 ± 0.94 of phosphate (mg of $P0_4$ /L).

Figure 2 shows the % phosphate accumulation (mg $P0_4$ /L), which was determined by the following equation: [(Concentration found in the study - initial concentration / concentration found) * 100].

The initial concentration was taken from the minimum permitted value according to EU Directive 75/440/EEC, which corresponded to 0.52 phosphate (mg $P0_4$ /L).

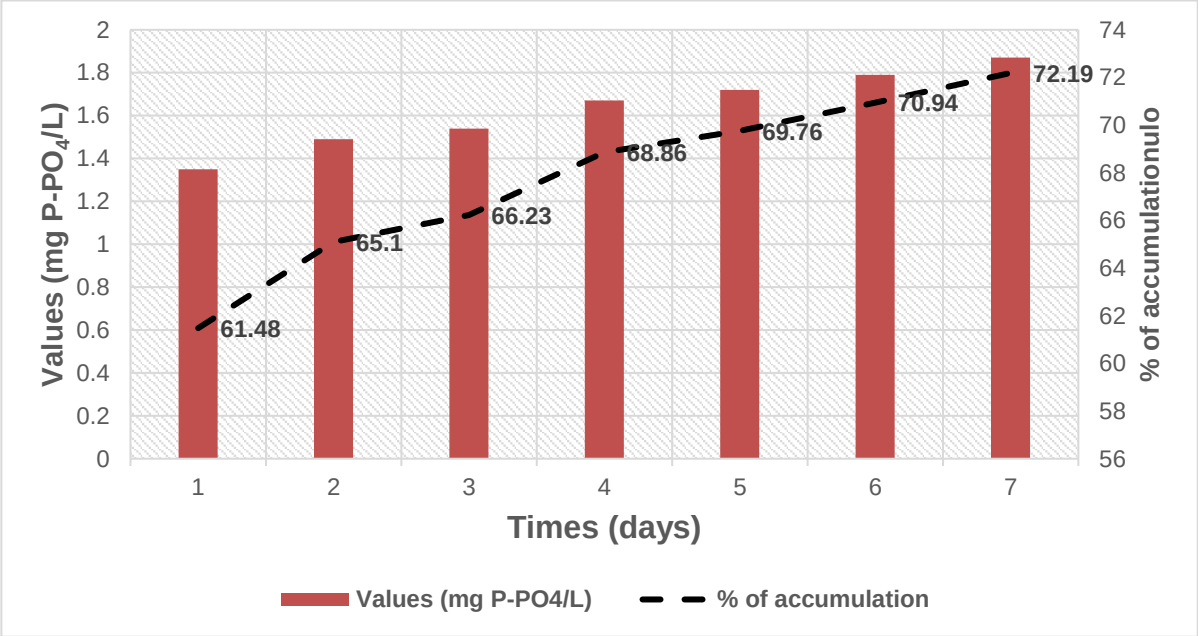


Figure 2. Percentage of phosphate accumulation in swamp waters in the department of Sucre.

The results obtained show that the concentration of phosphorus in the form of phosphate (mg of P04 /L) in the bog water used for human consumption and fish farming increases from day zero (day 1) 61, 48% to day 7 (90 day) increased 72,19% of phosphorus in the form of phosphate (mg of P04 /L) in the water.

Phosphorus is an essential element for life as a key nutrient limiting factor, however, it contributes together with nitrogen to the eutrophication of lakes and other water bodies. Phosphorus is found in natural and waste waters almost exclusively as phosphates, which are classified into orthophosphates, condescended phosphates (pyro-, meta-, and other polyphosphates) and organic phosphates. Phosphorus analysis involves two general steps; (a) conversion of the phosphorus form of interest to dissolved orthophosphate, and (b) colorimetric determination of the dissolved orthophosphate. The forms of phosphorus in a sample can be determined as total (without filtration), dissolved (in the filtrate of a sample passed through a 0.45 mm pore diameter filter) and in suspension (in the filtration residue if sufficient phosphorus is present to warrant such consideration) and comprise in each case: Total phosphorus (P): all forms of phosphorus present, determined after digestion.

Total phosphorus (TFP) is a measure of the concentration of biologically available total phosphorus and hence the quality of the water body. Not all total phosphorus is actually available to organisms; the biological availability of the element depends on many factors, including the species present and their concentrations (Murphey and Riley, 1962). At the regional and local level, environmental authorities regulate the maximum permissible limits of discharge to ensure the equilibrium of the water bodies receiving such discharges, however, there are still no known permissible limits established.

Total phosphorus in lotic bodies (rivers) is evidence of anthropogenic inputs from agricultural (fertilizers, herbicides, pesticides), livestock (manure), industrial and urban (sewage, discharges) activities.

The effects of phosphorus overdose on human health, according to Martínez and Saracho, (2009) include:

- Oral phosphorus overload causes acute kidney damage.
- Phosphorus is implicated in the progression of CKD (chronic kidney disease).
- Phosphorus is implicated in increased inflammation and infection in dialysis and CKD (chronic kidney disease) patients.
- Phosphorus is implicated in increased overall mortality and cardiovascular morbidity and mortality.
- Phosphorus is involved in vascular calcification at various levels.
- There is controversy as to whether atherosclerosis and Mönckeberg's sclerosis should be considered as a single pathology or two different conditions.

Furthermore, scientific studies have found numerous cause-effect relationships between the consumption of phosphate water and an increase in the incidence of cancer and neurodegenerative diseases. In addition, excessive phosphate consumption can cause health problems, including kidney damage and osteoporosis.

On the other hand, phosphates are considered a frequent pollutant in water bodies, considering that their main origin is from compounds applied as fertilizers in agricultural areas and from detergents used in urban and livestock areas. They can also be generated by soil erosion and decomposing organic matter discharged by industries, households and animal farms. Although not considered toxic to humans or animals, phosphates are important because of their indirect negative effects through eutrophication of surface water bodies, which refers to the exponential growth of algae and consequently an exponential decrease in dissolved oxygen, making conditions that are incompatible with life.

Phosphate ion (PO4-) is formed from inorganic phosphorus that exists as a mineral and contributes directly to the cycling of phosphorus in the environment. It can also exist in solution as particles, as loose fragments or in the bodies of aquatic organisms. Rainwater may contain different amounts of phosphates that leach from agricultural soils into nearby watercourses (Sanchez, et al., 2007).

Several studies indicate that elevated phosphate ion concentration can also come from natural soil constituents and minerals, as well as from manure and other organic matter from agricultural waste. These sources of pollution are washed or dumped into ditches, canals, streams, rivers and lakes, and constitute a serious environmental problem (Lavie et al., 2010). According to Lavie et al, (2010), phosphate pollution is considered a direct consequence of the use of fertilizers by agriculture, and the area of interest shows the disrespect of the headwater set-asides with the establishment of planting areas and agricultural use.

Finally, the phosphate ion often acts as a nutrient for algal growth (Baird, 2001), i.e. the higher the concentration of phosphate ($PO_4^-$), the higher the algal growth, which in turn affects the amount of oxygen in the water and thus the uncontrolled growth of living organic matter, leading to a higher rate of decomposition, which eventually leads to a frank process of eutrophication.

## CONCLUSION

It is necessary to promote an environmental culture in the entire population of the Municipality of San Benito de Abad, particularly in the livestock breeders and farmers of the area, which will allow them to make an adequate use and management of pesticides and swine waste, which would result in the reduction of water pollution and the conservation of the environment and, consequently, would reduce public health problems. This study demonstrates the urgent need for systematic monitoring of water quality for human consumption in this region, as well as in other areas of intense agricultural activity, due to the proven fact that these regions are highly vulnerable to pesticide contamination. Furthermore, it would be pertinent to update the current legislation in the country, in order to mitigate the situation of contamination of drinking water in agricultural areas and to take the necessary corrective measures to avoid environmental and human health problems when using the water from the marsh for human consumption and fish farming activities in the surrounding community.

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CONFLICT OF INTEREST. All the authors of the manuscript declare that they have no conflict of interest.

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