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# Evaluation of the Presence of Emerging Pollutants "Ibuprofen" from Water Resources, as a Strategy Oriented to Sustainable Development

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**Abstract :** Population growth, agribusiness development and daily activities that we develop as a society, involves generating alterations to our environment and surroundings. Currently, there is a growing interest in the emerging contaminants (EC), as they are composed of different origin and chemical nature, whose presence in the environment, or the possible consequences thereof, have not been studied, causing environmental problems, health and ecosystems risks. Some reviews give a strategy to solve the problem of dumping of these pollutants specifically "Ibuprofen" having a high rate of consumption worldwide because it has no restrictions on the sale.

Today, there is no policy to control these pollutants, and implementations of monitoring technologies are expensive because the concentration levels are very low and are difficult to stop. Its adverse effects on aquatic life, animals and humans are a growing concern. This article reviews recent studies on the properties, sources, fate and effects of these pollutants. Finally, it gives the suggestion and the risk management to control in a sustainably way these products from a clean development mechanism in relation to the creation and enforcement of environmental regulations.

**Keywords:** Emerging Pollutants, Sustainable Development, Ibuprofen, Environmental Impact, Treatment.

## Introduction

The impact on the environment is a concern that today is increasingly alarming, this is caused by man since there is no awareness of misuse given to different materials discharged into the environment; in addition to the exponential growth that has taken the population, more people generate greater expenditure of resources and waste production1. Since sustainability is affected a high rate on health and the environment being a complex issue in the world[1]. Today a topic of great interest is the presence of emerging contaminants, recently identified in water resources[2]. These EC pose a difficult problem because they are not biodegradable and usually have high toxicity to aquatic organisms, making an intervention in the human food chain causing various disorders and diseases.

These pollutants have different chemical and biological properties[3]. Several toxic effects have been associated with exposure to these EC and its components. These can be acute or chronic type, related to the type of compounds, the type of population exposed and the characteristics of such exposure[4].

For example with the industrialization, it has increased the use of resources which has generated pollution in ecosystems and degradation of natural resources. Therefore it is of great importance to reduce the rates of pollution generated by industrial activity[5]. For this reason there are several technologies that address this type of toxic wastes (by removing containing ions), among which are: precipitation, ultrafiltration, nanofiltration, reverse osmosis, electrodialysis and electrolysis. Certain methods can remove up to 99% of the toxicity of these low - concentration pollutants.

Unfortunately, despite its effectiveness, the high cost of installation and maintenance of these technologies makes it impossible to apply to small and medium enterprises. Consequently, the agroindustrial sector and daily activities that develop as a society involves aqueous discharges of highly polluting waste[6].

Before this, the challenges that must be met to minimize risks to drinking water and ecosystems are becoming larger[7],which remain unregulated and monitored by most of the countries[3]being a worrying problem of environmental legislation. In this article we reviewed studies through the presence of emerging contaminants "ibuprofen" in different water resource and its impact on these ecosystems from a sustainable perspective[8], through a review of their assessment, toxicological properties, sources, transport in areas of study, treatment and legislation.

## Method

The literature review has been made with ScienceDirect and Scopus data bases on the impact of emerging pollutants (EC) in relation to sustainable development consultation. The review was made only for articles between 2010 and 2014, but in some of them there were important information of previous years, which were used. About 120 items were consulted of which 60 were used for the review of this article. The importance of this issue is because of population growth, agro - industrial development and daily activities that develops as a society explaining changes about environmental and environment.

These emerging contaminants (EC) today are of interest because they are composed of different origin and chemical nature, whose presence in the environment, or the possible consequences of it, have not been studied, causing environmental problems, risk health and safety of the public consumption. One of the challenges that must be met to minimize the risks for drinking water and ecosystems[7] is the regulation and environmental legislation by most countries[9], developing the knowledge and methodologies necessary to measure and evaluate the effects and risks associated with a large number of emerging contaminants[10]. As in this case ibuprofen for its high rate of consumption consequent to according to the free sale, not proving sustainable because pollution sources of this drug that may vary in scope and composition generating public health problems at all economic, environmental and social development levels [11].

### Development of the Topic

### Emerging contaminants EC

Since the Industrial Revolution, a variety of chemical inventions has affected the environment and aquatic systems in urban environments [5]. Since then, there has been a concern and scientific interest, on the handling of different chemicals used in agricultural, commercial, domestic and industrial areas, thus leading to misuse and awareness, due to various anthropogenic sources that increased the levels of pollutants, item that go unnoticed in the society.

Most of these pollutants are not detected by sewage treatment plants, but their variety and presence in rivers can cause serious damage to human health and the environment. The remains of drugs are known as emerging contaminants, increase in rivers and aquifers for various reasons resulting from human activity and remains of medicines that are not fully assimilated by the body and pass sewage, drugs thrown away or the toilet, or residues of chemicals administered to animals washed away by rain[12].

These emerging pollutants, may be of different origin and chemical nature having hydrophilic functional properties (those that do persistent), many of these new compounds tend to be polar and water soluble, achieving be resistant to the environment[13,14]. The annual demand for these contaminants is high, related to world population growth, which implies a high rate of contaminationwill not be sustainable for any country, because their research is expensive and being their low concentrations is necessary to find new optimal

techniques and low cost to make it sustainable. Following is a review of recent studies on the sources, occurrence, fate and effects of the most common drugs such as ibuprofen.

**Ecotoxicological evaluation of EC**

Ecological concerns of emerging contaminants, lies in the low information and their biological effects, as well as in its potential ecotoxicological impact evaluation[15]. Today, the effects are not yet fully understood; however, many of these modulate in the endocrine system and the immune system indicating its potential on the homeostasis of aquatic organisms[16].Ecotoxicological models use micro -organisms, species of fish, crustaceans, among others, but they fail to describe the effect of drugs on aquatic communities. These tests are guaranteed by the Environmental Protection Agency of United States (EPA), are acute toxicity tests [17].

These tests were exposed by the Scandinavian Society of Cell Toxicology order to describe the toxicity of drugs. They have been of great importance for the description of toxic effects expressed as effective concentration 50 (EC50) and classify the substances as very toxic to aquatic organisms (<1 mg / L, evaluated in Dañina Magna), toxic with values close to 10 mg/ L, and harmful to aquatic life with values ranging from 10-100 mg L of the active ingredient (Methods for determination of ecotoxicity).

Evaluation in human and ecotoxicological risks caused by the environment and the EC remains difficult due to exposure and quantification of drugs because often there are no satisfactory data to determine your risk, causing a major environmental problem caused by accumulation in flora and fauna entering the human food chain and giving rise to various disorders and diseases.

**Why ibuprofen? And their toxicological effects**

Unlike the various contaminants found in water, drugs are molecules having physicochemical properties and biological activity on different organisms, their persistence in the environment facilitates bioaccumulation. These drugs because of its chemical structure tend to be polar and water soluble, remain persistent in the environment. Within their parameters these drugs have weak acidic and basic behaviors so that their distribution depends on the pH of the medium and the acidity constant (Ka). It is indicating that the bile of some fish by its lipophilic nature is a good matrix for drug analysis biomagnifications in aquatic ecosystems [18]. Also other of its properties is its high distribution and biomagnifications.

Ibuprofen addressed in this study, is classified as an analgesic drug and globally has a high rate of consumption, due to its counter and considered by high rate of self - medication [19]. In Colombia the annual employment is high and also presents a high rate of pollution in wastewater.

Toxic and ecological risks of this drug is found in the aquatic environment with chronic toxic effects (such as regeneration polyp inhibited and reduced reproduction, [20]) also the possibility of resistant bacterial strains develop ago these compounds are ineffective for the purpose for which they were designed [21]. Their concentrations in the environment and its toxic effects on organisms manage risks to human health and the environment, which causes a costly consequence in terms of environmental impact, and loss of biodiversity [22].

**Sources of EC**

The consumption of pharmaceutical products worldwide is high, especially in developed countries [23]. From various reviews, it was analyzed that consumption patterns and excretion of drugs, such as ibuprofen, which is ingested 276.1 tons annually[24]. These pollutants are generally released into the aquatic environment from point sources such as drugs excreted into the sewer system or landfills [25,26] wastewater effluent hospital, runoff breeding sites and aquaculture animals [27]. Even an apparent insignificant source as individual households can increase the level of pharmaceuticals in water through consumption and unused drugs through sinks and drains, as revised by [28]. These major sources of emerging contaminants reach the sewage plants (Table 1) in a minimum concentration worldwide. In rivers it is common to find these pollutants that go to other bodies of water, including aquifers, estuaries and marine systems.

**Table 1. Data of ibuprofen concentration in a concentration range (ng/l) measured worldwide [29].**

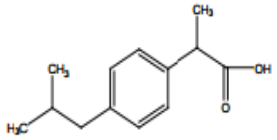
| Compound | Ng concentration range (ng l) | | | | | | Percentage of the compound excreted |
|---|---|---|---|---|---|---|---|
| Analgesics and antiinflammatory | North America | | Europe | | Asia and Australia | | |
| | Effluent treatment plants | Fresh water: rivers, channels | Effluent Treatment plants | Fresh water: rivers, channels | Effluent Treatment plants | Fresh water: rivers, channels | |
| Ibuprofen | 220 -3600 | 0 -34.0 | 134 -7100 | 14 -44 | 65 -1758 | 28 -360 | ≤ 5 |

**Studies on the fate and treatment**

Due to increased world population and growing demands for water supply in conjunction with the changes induced by climate and hydrological regimes, several pollutants entering these water bodies. Currently, treatment processes applied to reduce urban wastewater didn`tcompletely eliminate this type of pollutants with their subsequent release in terrestrial and aquatic environment affecting the food chain and the entire ecosystem through disposal and reuse[30]. Usually existing wastewater treatment plants were not designed for these unidentified contaminants.

Over recent years, studies have tried basically to optimize and develop technologies for wastewater treatment capable of eliminating satisfactorily these emerging compounds and prevent the spread of contamination in the aquatic environment. To limit or prevent these compounds from entering surface waters and aquifers, it has been studied the application of technologies that today are expensive but it is important because of the consequences involving these pollutants. For analysis of ibuprofen they have been primarily employed gas chromatography and liquid mass spectrometry to analyze their concentration (Table 2).

**Table 2. Antibiotics (Ibuprofen) reported in environmental matrix, [17].**

| Compound (Ibuprofen) | Ng matrix concentration (mg/L) | Method identification | Reference |
|---|---|---|---|
|  | Sediment: 35.83<br>Freshwater: 4.3 | HPLC/MS/MS | (Vázquez, 2011) |

These treatments are related to environmental and health policy. Currently in Colombia there aren`t environmental regulations for these pollutants and globally is not very versatile. To implement strategies for the EC treatments should have a clear regulation, to fulfill the minimum admissible avoiding high concentration rates that have occurred.

**Sustainable perspective of emerging contaminants**

Pharmaceuticals play an important role in society, but today with the high rate of population the demand for these products has increased unfavorably because sustainability is not analyzed, affecting society, economic , politically and environmentally. These products having chemical properties have environment and human health impacts, the problem that has arisen is the misuse that has occurred because the sale of these drugs has no restrictions, generating a high cost of consumption; the dose plays an important role[31]. In a broad spectrum of security, but largely hidden from the effects that unknown the patient. Reducing ambient levels will related to dose selection for prescribing/dispensing achieving reduction in multiple and interconnected using drugs to adverse human health impacts, the medical cost, public attention safety and environment, these drugs [32]promoted different problems not only social, also environmental (with attendant abuse, misuse, and other risks posed by self-medication).

Storage generated by consumers' unintentional poisonings having health problems. His reckless provision can amplify the introduction into the environment and generate social costs [33]. This lack of awareness brings problems to health resources. Environmental management of medicines involves in part the need to reduce the incidence of these pollutants in water resources [34], which reach the aquatic fauna, the terrestrial

environment and food sources. To achieve a sustainable strategy, it is necessary to promote optimal decreed pharmaceuticals consumption[35].

Today, there is no definite regulation for these pollutants. For this reason it is necessary to assess the risks of these chemicals to human health [36] and for the ecosystems since the implementation of environmental policies worldwide. It has also become clear that it is not possible alone, countries develop knowledge and methodologies for measuring and evaluating the effects and risks associated with a large number of emerging contaminants should be checked efficient technologies sustainably[37].

## Discussion

The identification and prevention of emerging contaminants in water is an environmental problem of great impact, because there are more pollutants, with different sources. Predicting the behavior that makes the environment poses a problem in different ecosystems which are filtered surface water, sediments, soil, groundwater, aquatic food web, as well as wastewater or potable water. To evaluate the transfer time of the different pollutants between different environmental compartments, is necessary innovative technologies of reliable analysis detection and sensitivity monitoring that detect these low concentrations, related with transportation modeling and destinations that have these pollutants and the spread and effects that bring to ecosystems (ecotoxicology) and human health (toxicology).

To achieve control and mitigation methods for the treatment and removal of contaminants such as ibuprofen and thus analyzed in the review, should develop, implement and evaluate measures for the sustainable management through environmental policies and technologies to control and reduce the spread and impact of emerging pollutants on water quality, achieving an improvement in the economic, social, political and environmental development.

## Conclusions

With the rapid economic development, better living conditions leads to longer life expectancy, which generated an increase in the world population giving place to increased demand for various products including pharmaceuticals bringing big environmental problems. These so -called emerging contaminants have a major environmental impact due to misuse given and the difficult removal in ecosystems among them, water resources, which come from different sources of transport. Although today there is a wide availability of sensitive analytical instrumentation to characterize these pollutants, the risk assessment on human health and ecosystems remains difficult, due to quantifying exposure is difficult because of its nature since treatment plants are not designed to measure in many countries because the concentrations are very low, also they are not yet as well known by society and are difficult to predict.

The data found in research papers, from Europe, America and Asia where environmental legislation is not defined arbitrary causing another problem to these contaminants. According to the research data they are not yet conclusive as to its ecotoxicology since concentrations are difficult to extrapolate in natural systems where sensitive species can be long - term exposure to multiple pollutants in relation to exposure and effects should be extended more research also, to take more stable measurements.

It also must know the different sources and from these develop methods fate and transport of contaminants as in this case of Ibuprofen, since this compound can reach the transferred terrestrial or aquatic food chain of consumer products in water waste from households, hospitals and industries, causing major problems in health and environmentally, in effect should regulate the sale of this medication, or analyze your dose, since, not being managed in a sustainable way, because consumer investment is high, being self-medicated, causing economic, political, social, cultural and environmental problems.

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