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RESEARCH ARTICLE

ARE DETERGENTS AND FERTILIZERS RESPONSIBLE OF WATER POLLUTION?

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ABSTRACT

This article reviews the use of detergents and fertilizers in agricultural activities that lead to water pollution, the consequences for the environment and public health. Currently, sustainable food production demands the use of clean technologies that avoid the excessive use of non-degradable detergents with poly-phosphates and sulphate as agents tense-active in livestock holdings and fertilizers, with high nitrogen and phosphorus contents in field crops, briefly discusses the regulation of phosphate and total phosphorus in wastewater and advocates the use of biotechnology as a decontaminant measure of chemical substances and the use of biodegradable detergents in order to avoid water pollution and environmental deterioration.

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INTRODUCTION

Currently the production of agricultural and livestock food must be sustainable and friendly to the environment, however in many places are use detergents non- degradable for washing in animal production units, households and industry; which may contain surfactants, in their formulation, which modify the surface tension of water and produce foam. Powdered detergents are those that have the highest content of surfactants, causing hardness and changes in pH in water, so the concentration of phosphates and sulfates in the water, will depend on the pH of the water, so a pH less than 5.8 and greater than 9 are dangerous (Goel and Kaurs, 2012). The detergents used in the milk basins can be discharged to the canals or rivers, accidentally, which cause chemical contamination (Casañas *et al.,* 2015). The climate, will also influence the concentration of contaminants in surface water (Goel and Kaur, 2012). In slaughterhouses around of semi-urban areas is another source of water contamination, due to the excessive use of detergents, for the cleaning of utensils, slaughtering, evisceration and boning areas of a considerable number of animals daily. The fertilizers used in agricultural activities such as superphosphates are another source of water pollution, being dragged by rain and winds from agricultural soils. It is estimated that the crops absorb between 20 to 40% of the fertilizers applied and the rest is discarded.

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So, the detergents with sulfates and phosphates non-degradable can be responsible for water pollution. So, the development of bio-fertilizers for some years, has been a strategy to avoid environmental damage; which contain microorganisms that live in symbiosis with the plants that help them nourish themselves and protect themselves from predators (Vessey, 2003). Among the most studied microorganisms are the mycorrhizal fungi that provide phosphorus to the plant, as *Fusarium oxisporum, Trichoderma aureoviridae, Aspergillus aculeatus (*Al-Taweil *et al.,* 2009); or like alternative to substitute synthetic fertilizers in agricultural fields (FAO, 2008).

Background: The first detergent for domestic use was manufactured and introduced in the United States in 1940 (Kogawa *et al*, 2017). Currently there are more than 400 commercial formulations whose degradation sometimes reaches 50%, as in the case of sulfates (alkyl-benzene sulfonate) and minimal degradation (10%) for the phosphates of the alkyl-phenol group (nonyl phenol). The residual water may contain protozoa (amoebas), according to Benito *et al.* 2018, who warned that these microorganisms can go through traditional purification processes, such as chlorination, due to their circular and resistant structure, which is why they are not eliminated. The water for domestic and agriculture use, can carry up to 70,000 synthetic compounds for daily use, which can't be eliminated with traditional treatment plants (González, 2004, Bajpai and Tyagi, 2007). Agricultural producers in some regions where exist the scarcity of water, they use wastewater

to irrigate their crops, agricultural management that has advantages, but also disadvantages, such as the presence of microorganisms, as bacteria, viruses, and parasites; additional chemical substances such as phosphates, nitrates and heavy metals. Since, it has been shown that sewage can inhibit up to 70% the growth of plants such as sunflower at a phosphate concentration of 10 ppm and up to 100%, if the concentration reaches 40 ppm. It has been reported that industry water contains about 3 148 mg / L of anionic surfactants and a COD of 11 423 mg / L (Aloui *et al*., 2009). The treatment plants are not adapted for the complete elimination of the organic substances as it was possible to appreciate in a preliminary study carried out in the Centro de investigaciones biológicas y acuículas de Cuemanco (CIBAC), in Mexico, since the nitrates were detected even after having passed through the filter activated carbon. The concentration decreased but approximately 10% of the initial content remained (Peña *et al*., 2017), whose source of contamination was probably the intensive agricultural activity, which is carried out in the vicinity and domestic wastewater, which according to world bank said in 2014, 75% of wastewater is discharged into water bodies without treatment in Latin America. The safety of food must consider not only the sanitary safety of water, but chemical and toxicological, since it is the vehicle of transmission of various diseases and intoxications to mammals. The gastrointestinal infections are the third cause of infant death in the State of Mexico and the fourth in Mexico City.

Main toxic components in wastewater

The phosphates: Phosphorus (P), is a very reactive chemical element that has multiple uses, is widely used in the detergent industry (Casañas, *et al*., 2015). A content greater than 0.5 ppm of phosphates (PO_4-P) causes foam, which prevents the entry of sunlight into the body of water, increasing the biological oxygen demand (BOD). The soluble phosphorus corresponds between 15 and 35% of the total of phosphates, the polyphosphates between 65 and 85% and in smaller proportion the condensed phosphates of high molecular weight and the organic phosphates, all of them differentiated by their chemical structure, which can be ortho - (PO_4 3-), meta- (PO_3-), pyro- ($P_2O_7^{4-}$) or poly- (PO_3) n-). Calcium phosphates have a dual behavior in water, because they are chemically long hydrocarbon chains at the end of which there is a cationic, anionic, amphoteric or polar group. By the number of hydrogens bound to the ionic element, mono- (Ca (H_2PO_4) 2), di- ($CaHPO_4$), tri- (Ca_3 (PO_4) 2) and tetra- (Ca_2P2O_7) are known. Sodium pyrophosphate ($Na_4P_2O_7$) and sodium tri-poly phosphate ($Na_5P_3O_{10}$) are inorganic phosphates widely used in hard water bodies, because they form stable and soluble complexes with cations (calcium, magnesium and iron), with the disadvantage of can act as nutrients for some aquatic microorganisms creating an imbalance (Khöler, 2006).

Sulfates (SO_4^{2-}): The presence of sulfates in the water can be due to the leaching of the land, rain, or the discharge of wastewater. The detergents contain sodium sulfonate, either straight or branched chain whose degradation is very slow, they are very abundant in nature and their content can vary, for example the concentration on sulphate iron in the soil conditions the presence of sulfates in nearby rivers; the exploitation of pyrite in mines increases the sulfate ion in the water, mainly due to the oxidation processes that the mineral undergoes during its extraction. The alkyl-aryl sulfonates are substances obtained from aromatic compounds with an aliphatic chain attached to the aromatic nucleus. Some of the properties are their high property detergents, moisturizing power, foaming power and resistant to acids and alkalis. Alkyl benzene sulfonate (ABS), ammonium lauryl sulfate (ammonium lauryl sulfate), ammonium lauryl ether sulfate (ammonium ether sulfate), sodium lauryl sulfate (sodium lauryl sulfate), have a high consumption worldwide that is from approximately 1,500,000 to 2,000,000 tons per year despite its low degradability and foaming power (Neilsen *et al.,* 2002). These substances present in wastewater passing through anaerobic purification plants can increase their concentration and be a risk to the terrestrial fauna, since a dose of 60 mg / kg is sufficient for its toxic effect on the reproduction of invertebrates (Mungray and Kumar, 2009).

Sodium dodecyl benzene sulfonate ($C_{12}H_{25}$-C_6H_4-SO_3Na), which according to the branches you have, can be classified as a persistent detergent (not degradable) or a biodegradable detergent. The effect of detergents to be thrown after domestic cleaning, from livestock farms and industries to lakes and rivers affected in different ways, its surfactant components cause the decrease of the solubility of oxygen in water bodies, they affect the process of photosynthesis and cause lesions on the gills of fish. Anionic surfactants, especially linear alkyl benzene sulfonates (SAL), should be of special interest since they have a special impact on aquatic and terrestrial ecosystems and are used in commercial consumer products that are discharged into wastewater after use. At concentrations of 0.02-1.0 mg L^{-1} in fish damage the gills, causing excessive secretion of mucus, decreasing respiration, as observed in the common goby (*Pomatoschistus microps*), may even damage larval swimming patterns of the blue mussel (*Mytilus edulis*). In sludge or sediments, a concentration of 40-60 mg SAL kg^{-1} is capable of interfering with the reproduction and growth of invertebrates and earthworms. It also affects plankton and crustaceans (Venhuis and Mehvar, 2004). The toxicity of the surfactant is determined by the absorption in the biological membranes and its penetration in the cell, the chemical structure of the chemical or surfactant since a hydrophilic head and a hydrophobic chain facilitates its entry, the hydrophobic part determines the ease in which it is inserted into the lipid bilayer of the cell membrane and the disturbance caused by the hydrophobic interactions once it is in the membrane causing its toxicity and causing the destruction of the function and structure of the bacterial membranes with the depolarization of the membrane, the decrease in the entry of nutrients and the excretion of substances by cellular metabolism (Cowan-Ellsberry *et al*., 2014).

Disastrous consequences for the environment: The eutrophication of continental and coastal waters is a generalized phenomenon around the world, since blooms or blooms of blue-green algae, toxins and foam are frequent, which could be considered as indicators of contamination. Algae are also a danger because they can synthesize hepatotoxin such as microcystin and neurotoxins, which have even caused poisoning in cattle. In Europe there is regulation for microcystin at 1 ppb (García, 2003). In people who have bathed in recreational waters may cause skin irritation or if they have accidentally drunk vomiting, diarrhea, muscle pain. In this sense, it is very important to emphasize that algae *Microcystis aeruginosa* and *Peridinium willei* have been identified in Xochimilco, a place near to Mexico (Figueroa *et al.,* 2015).

So, the inefficient water purification can cause various public health problems, such as gastroenteritis, keratitis, pneumonia, among other infections. A decrease of oxygen and the presence of phosphates, even at low concentrations is the delay they cause in the growth of plankton, increasing the concentration of methane (CH_4) and amines in the water, because 1 g phosphate-phosphorus PO_4-P, affects the growth of 100 g of algae. When these algae die, the decomposition processes result in a chemical oxygen demand (COD) of around 150 g, a parameter that is used to determine the quality of surface water bodies and water destined for irrigation. In addition to the dryness of lakes and the death of aquatic species (Garcia, 2003; Khöler, 2006).

Phosphorus phosphate-sulphate decontamination methods: To achieve the elimination of phosphates it is important to consider a mixed biological and chemical precipitation treatment (Aloui *et al*, 2009). Currently the use of biotechnology is also an option for bioremediation of water contaminated with nitrates and phosphates, using microalgae (*Scenedesmus incrassalutus*) can achieve a removal of 60% of the initial nitrates content and 47% for phosphates (Roa and Cañozares, 2012).

The regulation: In Latin America, special in Mexico, the regulation for the limits of basic pollutants in wastewater stipulates the biochemical demand for oxygen, total phosphorus and heavy metals. The NOM-001, stablishes the maximum permissible limits of contaminants for irrigation water and for public use. The wastewater must contain a total phosphorus level of 5 to 20 mg L^{-1}. If the content is between 51to 100 mg $L^{-1}$the water is regular and very bad if the range is higher (Rodríguez Ulloa, 1996). The European Parliament issued a resolution on the prohibition of detergents in 2015, after having monitored more than 1000 detergents from various industries during 2012 and 2014. Spain allows 10 ppm of degradable detergents, 100 ppm of phosphates, and 10 ppm for total phosphorus (Bajpai and Tyagi, 2007).

Conclusion

The sanitary, chemical and toxicological safety of the residual water must be a requirement for its reutilization, since the sanitation processes are not designed to eliminate chemical substances or micro-pathogens in their entirety, so it is necessary to implement innovative strategies in the supply network of the water. In addition to including periodic monitoring plans, depending on their location and use, within the environmental management in order to predict a possible risk. It is important to comply with the regulatory framework for chemical substances in reusable water for agricultural and livestock activities, which requires sensitive analytical techniques that ensure their results. The population should be made aware of not spilling wastewater in the water channels as well as the use of biodegradable detergents (<15% phosphates), in order to avoid damage to public health and the environment.

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