

# Roots of Antibiotic's Vicious Cycle through Aquatic Environment

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## Abstract

Antibiotics, ARGs, ARB and AMR have been frequently reported in aquatic environment, which has gained increasing concern as with explosion of antibiotics. The potential adverse effects of antibiotics, ARGs, ARB and AMR are undeniably tremendous. In this paper, we think that besides overconsumption of antibiotics, WWTPs, DWTPs, agriculture, aquaculture and livestock are the roots resulting in the vicious cycle of antibiotics through aquatic environment. Simultaneously, suggestions were given to mitigate the vicious cycle.

**Keywords:** Vicious cycle; Roots; Antibiotic; Aquatic environment

**Abbreviation:** WWTPs: Waste Water Treatment Plants; ARGs: Antibiotics and Antibiotic Resistance Genes; ARB: Antibiotic Resistance Bacteria; AMR: Antimicrobial Resistance; DWTPs: Drinking water treatment plants

## Introduction and Background

Antibiotics are defined as a kind of chemical therapeutic agents that kill or inhibit microorganisms. Since Alexander Fleming firstly isolated the antibiotic penicillin from the fungus *Penicillium* in 1928 [1], over 3000 different antibiotics have been founded or synthesized and more than 100 antibiotics have been applied in human and veterinary medicine as a preventive or curative treatment for bacterial infections. According to the global antibiotic consumption 2000 to 2010 analysis, consumption of antibiotic drugs increased by 35%, and BRICs countries account for 76% of the increase [2]. Researchers showed that a high percentage of antibiotics are excreted in an unaltered state via urine and feces into the sewage [3,4].

However, wastewater treatment plants (WWTPs) are not design for removal of micro pollutants, including antibiotics and antibiotic resistance genes (ARGs) [3], only partially eliminated in WWTPs, most of which was discharged into ambient waters (like rivers, lakes, reservoirs etc.) or groundwater [4]. Therefore, antibiotics have been frequently reported in aquatic environment, including groundwater, river water, WWTPs [5]. The existence of ARGs, antibiotic resistance bacteria (ARB), and antimicrobial resistance (AMR) has also been investigated in sewage, drinking water and surface water [6]. Study indicated that human suffer from many diseases (i.e. immune, metabolism) resulting from a systematic

effect on their body physiology by gut micro biota because of antibiotic exposure from aquatic environment [7,8]. Undeniably, serious threats to public health are existed resulting from human's exposure to antibiotics.

So are ARGs, ARB and AMR. The emergence and spread of ARB has been classified by the World Health Organization as one of the three biggest threats to public health in the 21st century [9]. Given the serious threats to global public health caused by AMR, an agreement was reached in the G20 Hangzhou Summit and UN General Assembly in 2016 to fight with AMR and to promote prudent use of antibiotics [10].

## Roots of Antibiotics' Vicious Cycle though Aquatic Environment

According the precious study, antibiotics production mainly supply for human antibiotics (Household, industry, hospital), agriculture or food processing and veterinary antibiotics (Aquaculture, livestock, poultry, pets) [11] Considerable proportion of antibiotics is excreted into aquatic environment in direct or indirect way in unchanged forms, releasing into sewage, penetrating into groundwater, discharging into surface water, rivers, reservoirs and lakes etc. We think that the following four aspects are roots leading to vicious cycle of antibiotics in aquatic environment:

**WWTPs:** WWTPs have been considered as hotspots and main sources of antibiotic, ARGs and ARB to release into various compartments of the environment [12]. Most of the used antibiotics are released into aquatic environment mostly by effluents from WWTPs. WWTPs is also particularly noteworthy that it has been regarded as collection points for ARB and breeding ground for ARGs to proliferate [13].

**Drinking water treatment plants (DWTPs):** As a disinfection method in DWTPs, chlorination was reported that it can elevate the total relative abundance of ARGs in opportunistic bacteria [14]. Study also showed that disinfection byproducts can induce the ARGs [15]. Subsequently, the possibility that antibiotics even ARGs enters into human or animals' body is elevated.

**Agriculture:** As was stated, antibiotics penetrate into sediment or soil in varieties ways (i.e. surface runoff). And then was uptake by the crops, which is toxic to primary producer and higher tropic level [16]. Ultimately, antibiotics even ARGs enter into human or animals' body through agriculture products.

**Aquaculture and livestock:** On one hand, direct discharge into rivers or land application of livestock wastes on agricultural lands is a common practice in countries that still have no specific treatment requirements for livestock wastes [5]. On another hand, antibiotics 'risk even ARGs-containing aquaculture and livestock products become higher because of the use of antibiotics contaminated rivers or lakes' water for aquaculture and livestock, aquatic. In conclusion, including antibiotics' overconsumption, WWTPs, DWTPs, agriculture, aquaculture and livestock are the real reasons resulting in the vicious cycle where antibiotics, ARGs, ARB and AMR interact with each other and all of them gradually increases in water cycle chain and food chain through aquatic environment. Measures from all aspects must be taken to avoid the inappropriate use of antibiotics. What's more, much more attention should be paid to WWTPs that have been regarded as hotspots and main sources of antibiotic releasing to environment. We think that advanced treatment (Membrane technologies, ozone disinfection, sorption etc.) has been imperative to enhance crucial role of WWTPs to eliminate antibiotics to the largest extent before the vicious cycle caused by antibiotics, ARGs, ARB and AMR become worse.

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