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Quantity, Species, and Origin of Fungi in a Groundwater-Derived Water Source

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Abstract: Fungi pollution in water can lead to serious problems, such as turbidity, odor, food pollution, mycotoxin production, and increased opportunistic infections among people with an immune deficiency. Few studies have reported the fungi community composition, quantity of fungi, and origin of fungi in groundwater. To study the change of quantity and community composition of fungi in groundwater at different times of year, this study evaluated the number of fungi and dominant fungi genera in groundwater and the factors affecting fungi quantity. The results showed that 18 genera of fungi were observed in the study area's groundwater, among which *Penicillium* (18–27%), *Aspergillus* (17–26%), *Acremonium* (12–28%) were the three most dominant. The numbers of dominant fungi genera were as follows: *Penicillium* (21–62 CFU/100 mL), *Aspergillus* (18–43 CFU/100 mL), and *Acremonium* (15–38 CFU/100 mL). The number of fungi in water closely correlates with environmental variables such as pH, dissolved oxygen (DO), turbidity, and total organic carbon (TOC). Various genera of fungi were affected differently by unique environmental variables. The fungi in the water were also affected by components of the external environment, such as rainfall, surface farming, surface water sources, and so on. This study aims to provide meaningful information for understanding fungi pollution in groundwater.

Keywords: fungi abundance; fungi genera; groundwater; *Penicillium*; *Aspergillus*; *Acremonium*

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1. Introduction

The World Health Organization (WHO) defines safe drinking water as water that will not cause substantial harm to human health during its consumption [1]. Most recent studies have focused on the pathogenic bacteria, viruses, and parasites that cause human health problems in drinking water. However, there are relatively few studies about the impact of fungi pollution in drinking water on human health problems [2–11].

Presently, research on the harmful effects of fungi in water has mainly focused on water odor, food pollution, and health problems such as skin lesions, allergies, and the increase of immune system infections in people with an immune deficiency [12–14]. Some fungi species belonging to *Aspergillus*, namely *A. fumigatus*, *A. flavus*, and *A. niger*, can cause invasive aspergillosis, thus increasing the population of susceptible people [15]. Some scholars have shown that the presence of various fungi will aggravate epidemics of infectious diseases and increase incidence rates of asthma [16–21]. These species may also increase the infection rate of acquired systemic mycosis within immunocompromised people [14,22]. Concurrently, fungi may also cause food and beverage pollution during food processing [13,14,23].

In recent years, owing to the intensification of water pollution and increasing attention paid to health problems, scholars have begun to study fungal pollution in water [23–27]. At present, research on fungal pollution in water bodies has mainly concentrated on bottled mineral water [28–30], tap water [26,31,32], and water supply systems [33,34].

Following in-depth research on fungi pollution, some researchers began investigating the fungi in groundwater. Previous research showed that fungi amounts vary considerably by location. In Portugal, the maximum fungal colony value reached 1000 CFU/100 mL [35]. The average number of fungal colonies in 68% of samples in Germany was 100 CFU/100 mL [36]. The number of Brazilian fungal colonies was 5–207 CFU/100 mL [37], and that of Poland was 20–500 CFU/100 mL [33]. The number of fungal colonies in Australian groundwater was 33–97 CFU/100 mL [38]. The differences in the fungi number in different countries can probably be explained by the fact that the growth of fungi is affected by various water quality conditions and the specific environmental characteristics of the individual aquatic environment [33]. The number of fungi is affected by nutrients, temperature, pH, acidity, calcium content, and other situations, such as the culturing method, system maintenance, renovations, failures, pipeline breaks, etc. [22,31–33,35,39–41].

There are relatively few studies on fungi in groundwater at present, and fungi numbers vary considerably by region [1,23,31]. This problem is especially acute in China, where the pollution of fungi in groundwater sources has not been reported. Groundwater exists at a relatively deep depth, this environment is relatively closed, and no study has reported the origin of fungi in groundwater. Concurrently, the quality of groundwater is better than that of other water sources, and the treatment process of water plants with groundwater as a water source is, generally, relatively simple. This is mainly because direct disinfection and supply are possible, as well as simple filtration, subsequent disinfection, and other relatively simple treatment processes. There is no specialized study on the controlling efficacies of these treatments on fungi and fungal spores.

At present, groundwater pollution is serious, which can be roughly attributed to excessive iron and manganese, microbial pollution, ammonia nitrogen and nitrite content, hardness, sulfate, and nitrate [42,43]. The composite pollution of water conditions may promote the growth of filamentous fungus spores in the water source and distribution system.

Groundwater has always been supplied after disinfection or simple purification (such as filtration) in groundwater supply systems. Fungi have been proven to be more difficult to inactivate than bacteria. The disinfection showed poor control efficiency on fungal mycelium and spores, which caused spores to break out through the water treatment and posed a potential risk to the safety of drinking water [44].

This study aims to explore the variation and influencing factors of fungal contamination in groundwater and to further analyze the pollution characteristics and source of fungi in groundwater. Finally, we want to determine whether the current drinking water treatment processes can effectively remove these organisms and potential secondary metabolites.

2. Materials and Methods

2.1. Description of Study Area

The study was conducted in the northern suburb (34°20′ N, 108°47′ E) of Xi'an, Shanxi province. This area is located in the western region of China, at an average elevation of 1127 m and with a mean annual temperature of 18.3 °C. There are 35 groundwater wells in the study area that represent an important drinking water source for the Xi'an No. 5 water treatment plant; their daily water supply is approximately 100,000 tons, and the wells serve almost 100,000 people. The wells' depths range from 112 to 315 m.

2.2. Sample Collection

(1) Groundwater sampling method.

Water samples were collected monthly from the 35 designated groundwater wells between April 2014 and May 2015, with 683 samples collected. All the samples were accompanied by travel and field blanks. Before samples were taken from the outlet pipe of a submersible pump, water was discarded continuously for 5 min and then collected

using clean one-liter sterile polyethylene bottles. All samples were kept in the dark, directly transferred to the lab, and kept at 4 °C in a refrigerator for further analysis.

(2) Surface water sampling method.

Three sampling sites of Weihe River surface water were collected along the river (the sampling depths were 0–20 and 20–40 cm for each sample). The backwater area of the river has been avoided, and floating leaves and impurities have been removed. All the samples were accompanied by field blanks. All samples were kept in the dark, directly transferred to the lab, and kept at 4 °C in a refrigerator for further analysis.

(3) Soil sample sampling method.

Two representative ground soil sampling points were designated in vegetable fields, forests, and orchards. Samples were taken before and after irrigation. The sampling depths were 0–10 cm, 10–20 cm, and 20–30 cm for the surface layer and 500 g for each soil layer. Visible tree roots, stones, and other debris were removed; the samples were then mixed, and 100 g was kept for laboratory analysis.

(4) Rainfall influence investigation experiment.

The present experiment selected two rainfall processes in November (First rainfall time: 17 November 2015; rainfall duration: approximately 16 h; rainfall: 6.4 cm. Second rainfall time: 23 November 2015; rainfall duration: approximately 8 h; rainfall: 2.47 cm) as the research objects. The fungi change in groundwater before and after the rainfall events were investigated. The sampling method before and after rainfall was the same as that of groundwater.

The above sampling process was a sterile operation.

2.3. Water Source Soil Leaching Test

The soil sample (10 g), after sieving, was weighed and put into a 250 mL flask containing 90 mL sterile water and 20~30 small glass beads (5 mm in diameter). The soil sample was placed on a vortex oscillator and oscillated sufficiently to form a 10^{-1} soil diluent. 1 mL of 10^{-2} soil diluent was taken and transferred into a test tube containing 9 mL of sterile water. After sufficient vortex, 10^{-2} soil diluent was formed. Each soil sample was repeated three times. Two dilutions of 200 µL soil diluents were taken and coated on a cooled selective medium. Each dilution was coated with 5 plates and cultured in a constant temperature incubator at 26 °C for 3–5 days. Suspected colonies were selected and identified.

2.4. Water Quality

The main conventional water quality parameters include Water temperature, DO, pH, Turbidity, TOC, total nitrogen (TN), total phosphorus (TP), ammonia-nitrogen (NH_4-N), and permanganate index (COD_{Mn}). All of these water parameters were determined with standard methods according to Standard Methods for the Examination of Water and Wastewater [45].

2.5. Isolation of Fungi

To enumerate the species and distribution of fungi, Dichloran Rose Bengal Chloramphenicol (DRBC), a typical culture media for fungi isolation, was used in this study [46]. Antibiotics were added (chloramphenicol and streptomycin sulfate, 100 mg/L and 50 mg/L, respectively) to inhibit bacterial growth during culture media use.

To perform fungal isolation, membrane filtration techniques were used, as described in a previous study (Standard Method 9610) [45].

2.6. Identification of Fungi

According to the method described in a previous study [1], potato dextrose agar (PDA) was used as the medium for the purification of fungi. Regarding macroscopic characteristics, the color, diameter, texture, exudate production, and zonation were recorded [1,14,47–50].

3. Results and Discussion

3.1. Occurrence Rates of Fungi Genera

As shown in Figure 1, 18 genera of fungi were detected through the plating method, among which the most common genera were *Penicillium*, *Aspergillus,* and *Alternaria*. The relative abundance of the most common genera is *Penicillium* (18%), *Aspergillus* (14%), and *Alternaria* (12%). Almost all of these genera have reportedly occurred in aquatic environments in previous studies [1,26,35,36,51].

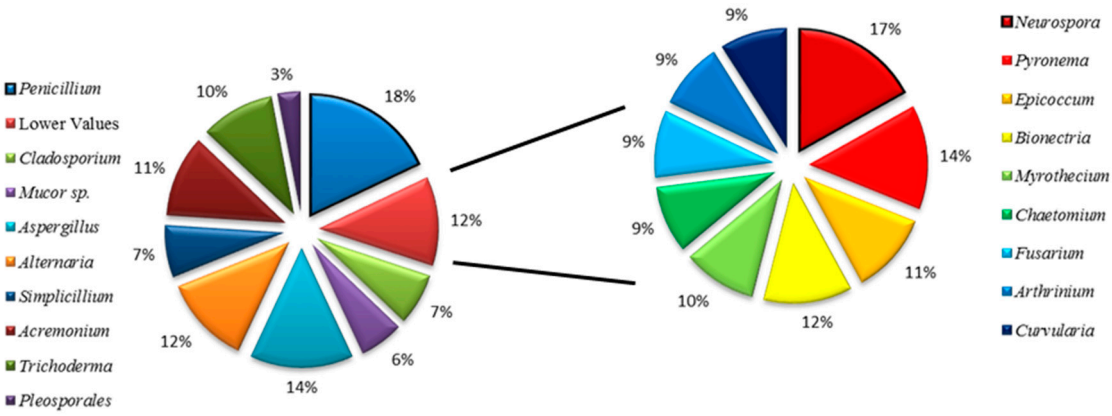

Figure 1. Percentages of different genera of fungi in groundwater (683 water samples) arranged clockwise. The black-bordered box represents the starting position. The right chart demonstrates the fungus genera with relatively small detection amounts (its total detection amount accounts for 12% of the left pie chart).

The fungi genera with low detection rates were *Pyronema* (0.38%), *Epicoccum* (0.30%), *Bionectria* (0.25%), *Myrothecium* (0.25%), *Chaetomium* (0.17%), *Fusarium* (0.15%), *Curvularia* (0.12%), *Arthrinium* (0.11%), which have already been reported to exist in aquatic environments. Other genera, such as *Neurospora*, *Pyronema*, and *Simplicillium*, have not been reported in freshwater but are commonly found in seawater, according to previous studies [35,51].

3.2. Abundance of Fungi in the Water Source

Figure 2 demonstrates fungi which were ubiquitous year-round (Figure 2a). The highest number of fungi (109 CFU/100 mL) occurred in summer (20 August), with the lowest (36 CFU/100 mL) observed in winter (18 February). It was speculated that fungi were more common in warmer and wetter climates. The results are in accordance with other studies that appear to confirm this dynamic [35]. The number of genera detected varied between 5 and 12 during the year. The highest number of genera was found on 14 July, and the lowest numbers were observed on 20 May and 23 November. The highest number of fungi and the highest number of genera did not occur at the same time. Similar conclusions have been reported in a previous study [32].

Figure 2b presents the genera of observed fungi and their corresponding numeric frequencies in different samples over time. As expected, the genera and the quantities of fungi in water showed significant differences over one year. *Penicillium, Aspergillus,* and *Acremonium* were the most common genera found in the different groundwater samples and were observed throughout the year. However, the frequencies of these genera changed at different sampling times. The range of *Penicillium* fluctuated between 18% to 27%, *Aspergillus* fluctuated between 17% to 26%, and the range of *Acremonium* fluctuated from 12% to 28%. This illustrates that these genera may have a wide natural distribution.

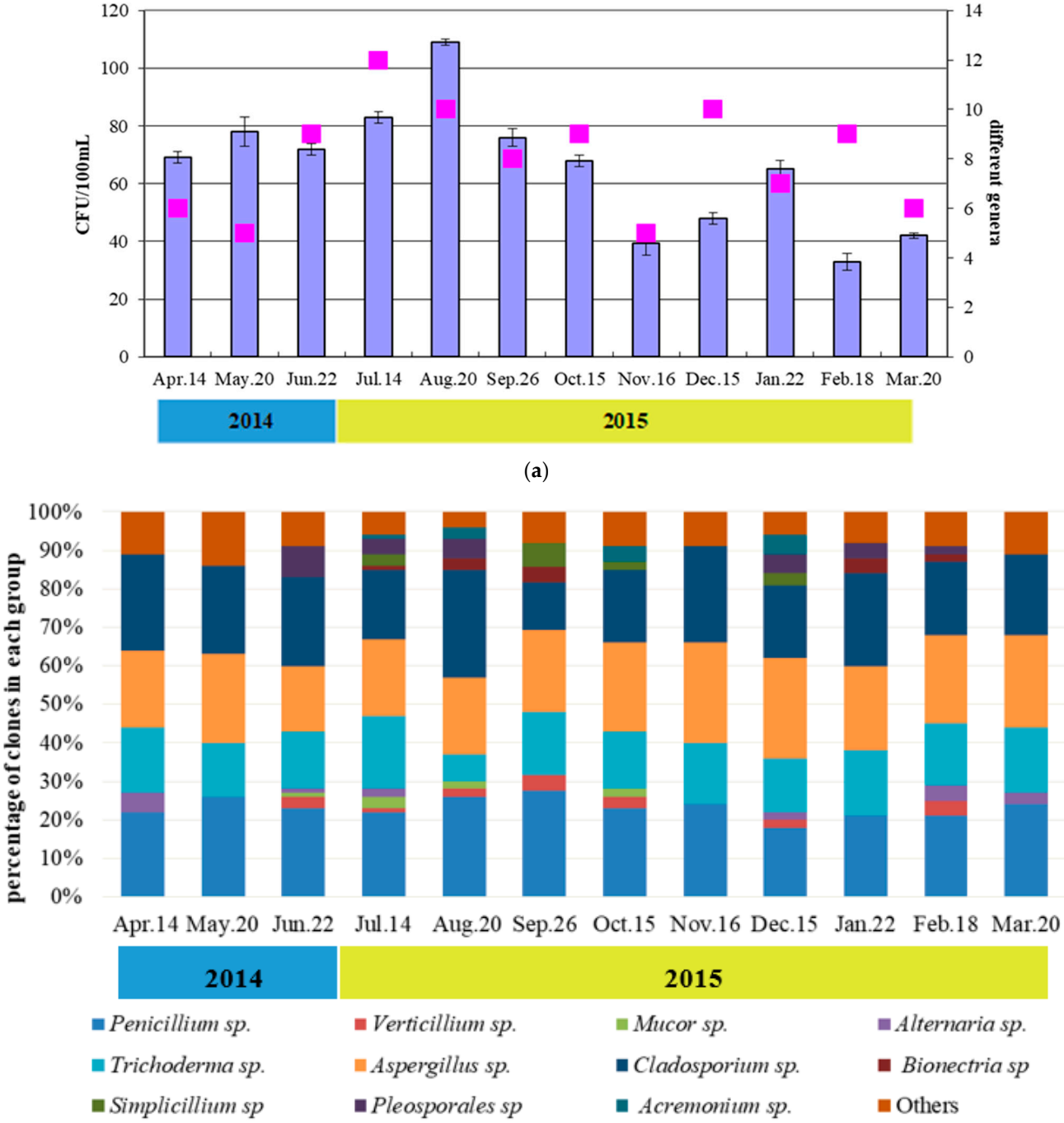

Figure 2. Relative abundances of fungi genera in the groundwater samples at different times. (**a**): Fungi occurrence levels in CFU/100 mL (blue bars: primary *y*-axis) and different colonies (purpledots: secondary *y*-axis) in the different samples. (**b**): Percentages calculated from the total number of genera for each group as shown during the various seasons.).

3.3. Impact of Water Quality Parameters on Fungal Genera's Abundance

3.3.1. Routine Water Quality Analysis

The water quality parameters and total bacteria count are shown in Table 1.

Table 1. Water quality indicators and total bacteria count of the samples. Values are presented as follows: minimum and maximum values determined during sampling events (average).

Parameters	Value	Quality Standard for Groundwater of China (QSGC) (GB/T 14848-9)
pH	7.5–8.9 (8.1)	6.5–8.5
Temperature (°C)	17.1–25.2 (21.7)	NG
COD_{Mn} (mg/L)	0.37–5.4 (1.9)	3
Dissolved oxygen (mg/L)	2.09–6.88 (3.35)	NG
Total Fe (mg/L)	0.06–0.86 (0.12)	0.3
Manganese (mg/L)	0.01–0.15 (0.08)	0.1
Total phosphorus (mg/L)	0.01–0.17 (0.10)	NG
Total nitrogen (mg/L)	0.01–0.58 (0.14)	NG
Turbidity (NTU)	0.04–1.17 (0.26)	3
TOC (mg/L)	0.08–2.56 (0.96)	NG
Total cell count (1×10^5 cells·mL^{-1})	1.2–93.1 (24.4)	NG

Note: NG—not given.

Most water quality indicators exceeded the maximum acceptable level outlined in QSGC (GB/T 14848-9); the only exceptions were indicators that were not included in the QSGC to begin with. Only turbidity met the QSGC criteria during the sampling period.

3.3.2. Correlation between Fungi and Environmental Parameters

The correlation between fungi in water and conventional water parameters, such as water temperature, pH, and turbidity, is shown in Figure 3. The cosine value of the angle between environmental variables and fungi represents the correlation between them, i.e., an acute angle represents a positive correlation. *Aspergillus* and *Acremonium* demonstrated strong correlations with UV_{254} and ammonia nitrogen in the water. *Penicillium* showed strong correlations with pH, turbidity, and TOC.

The environmental variables that have a strong correlation to different fungi include pH, DO, turbidity, and TOC. Therefore, the pH values had a strong impact on the biological activities of microorganisms in several aspects. First, it changed the charge of biological macromolecules such as proteins and nucleic acids, thus affecting their biological activities. Second, it changed the charge of cell membranes, resulting in changes in the ability of microbial biological cells to absorb nutrients. The third was to change the availability of nutrients and the toxicity of harmful substances in the environment. Various fungi have different requirements for pH conditions. The suitable pH value for the growth of fungi is 6.5–8.5.

DO provides oxygen for the growth, reproduction, and metabolism of microorganisms. Due to the growth and reproduction of fungi will consume dissolved oxygen, the number of fungi in water is negatively correlated with dissolved oxygen.

Turbidity is related to suspended particulate matter in water. The adsorption of particulate matter and some nutrients adsorbed on its surface provided a place and nutrition for the growth of fungi. Therefore, the number of fungi in water is positively correlated with turbidity.

TOC indicates the total organic carbon content of organic matter in water. COD represents the chemical oxygen demand, indicating the amount of oxygen consumed by oxidizing a unit volume of water with a chemical oxidant. Fungi are heterotrophic organisms that need external carbon sources for growth and reproduction. Microorganisms need oxygen for growth and reproduction, so their growth and reproduction are related

to TOC and COD. It has been found that fungal counts, survival, growth rate, and ability to reproduce could be affected by temperature [36], assimilable organic carbon (AOC), phosphorus ammonium, and nutrient concentration [32,52].

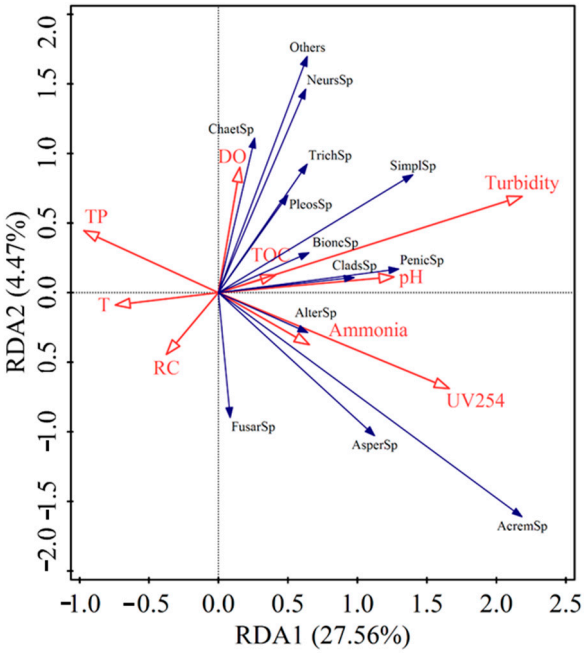

Figure 3. Redundancy analysis (RDA) between the fungi and environmental variables. Fungis are represented by blue arrows (PenicSp = *Penicillium* sp.; FusarSp = *Fusarium* sp.; BioneSp = *Bionectria* sp.; AlterSp = *Alternaria* sp.; TrichSp = *Trichoderma* sp.; AsperSp = *Aspergillus* sp.; CladoSp = *Cladosporium* sp.; NeuroSp = *Neurospora* sp.; SimplSp = *Simplicillium* sp.; ChaetSp = *Chaetomium* sp.; PleosSp = *Pleosporales* sp.; AcremSp = *Acremonium* sp.). Numbers in brackets represent the percentage of variation of the data explained by each factor, RDA1 explains 27.5% of the total variation, and RDA2 explains 4.4% of the total variation. The primary factors for the variables of the environmental data are represented by red arrows (DO = dissolved oxygen; T = temperature; TN = total nitrogen; TP = total phosphorus; RC = total number of fungal colonies).

3.4. Tracking Fungal Sources

3.4.1. Changes of Fungi after Rainfall

Groundwater exists in a relatively closed underground environment, and the literature on fungi sources in groundwater is relatively small. The recharge of groundwater mainly depends on the infiltration of surface water. Rainfall is an important part of the water cycle in nature. Because of the leaching and infiltration of rainfall, the groundwater system is bound to be affected. Therefore, the quantity and species of fungi in groundwater may be affected by rainfall. During the two rainfall periods, the water from representative wells 2#, 9#, and 42# in the northern suburb source area was sampled and analyzed. The sampling period was 4 days, and the sampling time nodes were before, during, and after the rain.

Figure 4 demonstrates that the number of fungi in groundwater increased significantly with the rainfall. The time nodes of the maximum number of fungi during the two rainfall periods slightly differed, but the number of fungi increased significantly within two days after the rainfall. The number of fungi decreased with the end of the rainfall period. The results indicated that surface precipitation could significantly affect changes in the number of fungi in groundwater. Studies have shown that fungi in groundwater will increase significantly in groundwater after rainfall and flood events [31,41].

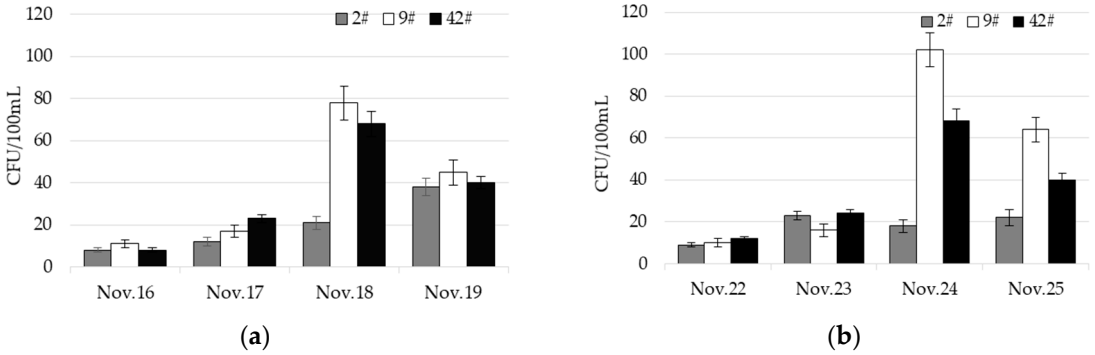

Figure 4. Variation of fungi quantity in water source wells during rainfall ((**a**): Rainfall during 16–19 November 2015. (**b**): Rainfall during 22–25 November 2015).

The first rainfall ended on 19 November 2015, and the second began three days later on 22 November 2015. The first rainfall was large, resulting in the soil water content was still high after the rain stopped. This may provide conditions for the fungi in the soil or surface water to infiltrate further into the groundwater system, so a higher content of fungi was observed in the rainfall that began on 22 November 2015.

3.4.2. Analysis of Soil Leaching Results

The scope of the water source protection area is approximately 1.5×10^6 m^2. Through social and economic development, the protected areas demarcated in the 1960s have been gradually affected by modern industry and agriculture. The main agricultural activities currently existing on the surface of the water source area include vegetable planting, greening land, and fruit tree cultivation land. Owing to the irrigation requirements of vegetable fields, orchards, and other economic crops, irrigation water seeps into the deep soil layer through the soil surface and then into the deep groundwater environment through cracks. Therefore, infiltration through irrigation may constitute one of the sources of fungi in the groundwater system. Studies have shown soil particles also contributed to lowering the water quality [53].

Two sampling points were selected from representative vegetable fields, forest lands, and orchards (the sampling method is detailed in Section 2.2) to analyze and study the quantity of fungi from the soil. Concurrently, a quantity analysis experiment of soil fungi before and after artificial simulated irrigation was performed for vegetable fields occupying a large area of the surface of the water source (the sampling method is also detailed in Section 2.2).

Figure 5 shows that fungi content in all kinds of soil environments on the ground was high. Although the isolation and cultivation methods of fungi in surface water and soil and the counting methods differed, the density of spores or mycelium per unit mass was higher than that in surface water. The number of fungi detected in different soil environments also differed. Specifically, the detection frequency of fungi was higher in orchards and lower in vegetable fields. This might be related to the relatively soft soil in the orchards and the large numbers of other surface humus inputs, such as fallen leaves, which provided a strong nutritional basis for the growth and propagation of fungi. Because the irrigated land was planted in rotation, the coverage of surface vegetation is intermittent. Moreover, its soil was relatively dense compared with the orchard soil due to frequent irrigation, with slight hardening occurring, so the number of fungi is small. In addition, because pesticides would be inevitably applied during vegetable planting to prevent diseases and pests, these pesticides may also inhibit the growth of fungi to a certain extent. Concurrently, the comparison showed that the changing trend of the number of fungi in the vertical direction is consistent for different types of soil environments. It could be explained that the shallow soil layer provides better nutrition conditions for the propagation and growth of fungi. Studies have shown that physical openings in storage facilities and lack of cover

allow microorganisms to be introduced from the air, animals, the introduction of untreated surfaces or groundwater, etc. [41]. All service reservoirs in England and Wales are covered, and vents are protected by gauze to prevent animals from gaining access [12,54].

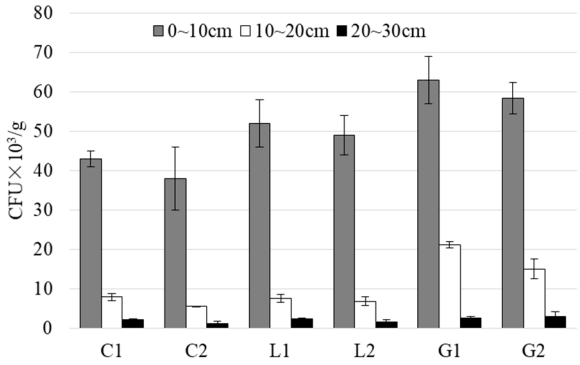

Figure 5. Fungi count in different soil samples. C1, C2: vegetable fields sampling point 1 and 2; L1, L2: forest lands sampling point 1 and 2; G1, G2: orchards sampling point 1 and 2.

As shown in Figure 6, the change in fungi number in the 0–10 cm soil layer of vegetable fields was negligible before and after irrigation. However, the number of fungi in the 10–20 and 20–30 cm soil layers increased significantly. This is explained because irrigation moistens the soil and provides the necessary conditions for the propagation of fungi. In addition, owing to the infiltration of the water flow, the introduction of fungi from the topsoil into deeper layers also explained why groundwater fungi increased significantly after summer downpours.

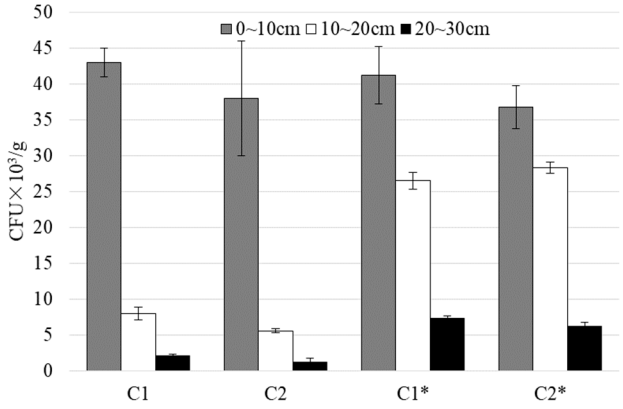

Figure 6. Fungi count in soil before and after irrigation in vegetable fields. C1, C2: vegetable fields sampling points 1 and 2 before irrigation; C1*, C2* vegetable fields sampling points 1 and 2 after irrigation.

In addition, compared with fungi observed in the water treatment process of underground water source wells and water plants, the quantity of fungi in different ground soil environments and surface water was higher. Thus, we inferred that fungi in soil and surface water are the sources of fungi in groundwater. In addition, quantitatively, soil fungi should account for a relatively large proportion of these migrations, which was another reason why groundwater fungi increased significantly after summer downpours.

3.4.3. Adjacent Waters (Changes of Fungi in Weihe River)

Surface rivers, lakes, ponds, and other water sources, as a supplement to underground water sources, their fungal frequencies, and the ecological environment, will inevitably migrate owing to their own mobility. The fungus ecological environment of Weihe River,

as the largest surface recharge source in the water source area, has an important impact on its groundwater environment.

Figure 7 demonstrated that a large number of filamentous fungi were present in the Weihe River water, and the change of fungi number in the surface water was negligible. The number of fungi in the surface water was relatively large because of the high content of nutrients and oxygen in the surface water. Among the three sampling points, the number of fungi in sample W3 was a little higher than that in other sampling sites. The reason, perhaps, was that the sampling sites were located in the river bay, and the water was relatively static. This location provided stable conditions for the reproduction and growth of fungi. It has been reported that the isolation of fungi was more likely from surface water-derived drinking water than groundwater-derived. Surface waters tend to contain larger amounts of organic matter, providing both nutrients and a substrate for fungal growth [32,51].

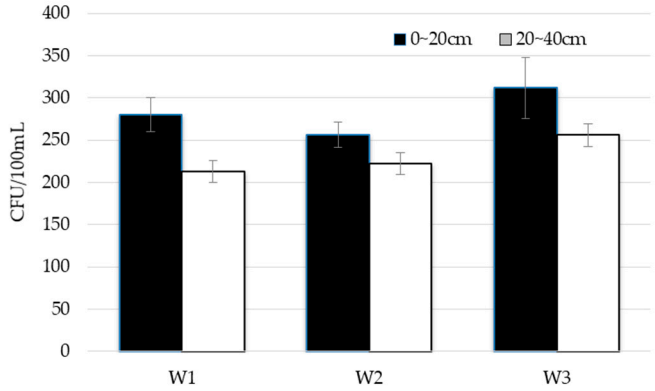

Figure 7. Fungal quantities at different sampling sites in the Weihe River. W1, W2, W3: Sampling points 1, 2, and 3 of Weihe River surface water.

The number of filamentous fungi in the Weihe River water was 2–10 times higher than in underground water source wells. In addition, the number of fungi genera in the Weihe River water was also relatively high and generally more than that in the groundwater. In terms of genera distribution, several genera that were dominant in groundwater were also found in Weihe River water, and the total number of fungi in Weihe River water was also high. This is consistent with the distribution of fungi genera and genera in groundwater. Therefore, the seepage and recharge of Weihe River water may introduce some fungi in surface water into groundwater environments. Hageskal et al. [32] found that a greater proportion of surface water-derived drinking water samples were positive for fungi than groundwater-derived samples.

4. Conclusions

Firstly, the characteristics of fungal pollution in groundwater were systematically analyzed. Secondly, the source of fungi in groundwater was explored in multiple dimensions. This study revealed the species of fungi in groundwater and the variety of species, abundance, and population characteristics of fungi in groundwater with seasonal changes. A total of three fungi genera were observed in an aquatic environment, and seven were observed in a groundwater environment for the first time.

The results indicated that the number of fungi in water closely correlated with environmental variables. In case of drastic changes in environmental conditions, such as floods and heavy rains, we must pay attention to strengthening the monitoring of the number of fungi in groundwater.

In conclusion, the present study examined the abundance and diversity of fungi communities. Future research will aim to control the propagation of fungi in groundwater and improve the safety of drinking water.

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Data Availability Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Abbreviations

CFU	Colony forming units
DO	Dissolved oxygen
TOC	Total organic carbon
TN	Total nitrogen
NH_4-N	Ammonia-nitrogen
TP	Total phosphorus
COD_{Mn}	Permanganate index
COD	Chemical oxygen demand
DRBC	Dichloran Rose Bengal Chloramphenicol
PDA	Potato dextrose agar
T	Temperature
NG	Not given
UV_{254}	Ultraviolet transmittance
AOC	assimilable organic carbon
WHO	The World Health Organization
RDA	Redundancy analysis
RC	Total number of fungal colonies
QSGC	Quality Standard for Groundwater of China.
GB	Guo Biao
PenicSp	*Penicillium* sp.
FusarSp	*Fusarium* sp.
BioneSp	*Bionectria* sp.
AlterSp	*Alternaria* sp.
TrichSp	*Trichoderma* sp.
AsperSp	*Aspergillus* sp.
CladoSp	*Cladosporium* sp.
NeuroSp	*Neurospora* sp.
SimplSp	*Simplicillium* sp.
ChaetSp	*Chaetomium* sp.
PleosSp	*Pleosporales* sp.
AcremSp	*Acremonium* sp.

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