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Research Article

Removal of Dissolved Organic Matter in Drinking Water Using Active Microorganisms (EM)

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Abstract

Conventional treatment methods are used in the treatment of drinking water to protect human and environmental health. These methods can be named aeration to increase the amount of oxygen, precipitation, chemical treatment, filtration, chlorination for disinfection. Besides, iron and manganese removal operations are performed in places where the hardness is very high depending on the geographical location, iron and manganese removal operations are performed in cases where the iron and manganese content is high. Drinking, and drinking water treatment technologies in Turkey are generally the same. The conventional methods used are briefly described as ventilation, coagulation, flocculation, precipitation, sand filtration, and chlorination. In recent years, it has been observed that in addition to these methods, ozone has been used for primary disinfection purposes, activated carbon adsorption for advanced purification purposes, reverse osmosis studies have been performed. Conventional treatment plants are usually built when there is the use of superficial water sources. In settlements where spring or well water is used in a certain area, the water is only available by the chlorination process. The purpose of drinking water treatment is to be clear, colorless, odorless, disease-causing organism-free, free of chemicals harmful to health, and suitable for domestic use. The treatment technologies used in drinking water treatment plants vary depending on the properties that are desired to be found in purified water, as well as the properties of raw water. Physical, chemical, and biological purification, which is one of the classical methods used in the purification process, may be insufficient in the face of dissolved organic matter. This encourages us to look for new methods of combating dissolved organic matter.

Keywords: Active microorganism, Purification, Drinking water, Water treatment.

Aktif Mikroorganizmalar (EM) Kullanılarak İçme Suyundaki Çözünmüş Organik Maddenin Uzaklaştırılması

Öz

İçme sularının arıtılmasında insan ve çevre sağlığını korumak için geleneksel arıtma yöntemleri kullanılmaktadır. Bu yöntemler oksijen miktarını artırmak için havalandırma, çöktürme, kimyasal arıtma, filtrasyon, dezenfeksiyon için klorlama olarak adlandırılabilir. Ayrıca coğrafi konuma bağlı olarak sertliğin çok yüksek olduğu yerlerde demir ve mangan giderme işlemleri, demir ve mangan içeriğinin yüksek olduğu durumlarda ise demir ve mangan giderme işlemleri yapılmaktadır. Türkiye'de içme ve içme suyu arıtma teknolojileri genel olarak aynıdır. Kullanılan geleneksel yöntemler kısaca havalandırma, pıhtılaşma, flokülasyon, çökeltme, kum filtrasyonu ve klorlama olarak tanımlanmaktadır. Son yıllarda bu yöntemlere ek olarak birincil dezenfeksiyon amacıyla ozonun kullanıldığı, ileri saflaştırma amaçlı aktif karbon adsorpsiyonunun kullanıldığı, ters ozmoz çalışmalarının yapıldığı görülmektedir. Konvansiyonel arıtma tesisleri genellikle yüzeysel su kaynaklarının kullanıldığı durumlarda kurulur. Kaynak veya kuyu suyunun belirli bir bölgede kullanıldığı yerleşim yerlerinde, su sadece klorlama işlemi ile elde edilmektedir. İçme suyu arıtımının amacı; berrak, renksiz, kokusuz, hastalık yapıcı organizmalardan arınmış, sağlığa zararlı kimyasallardan arındırılmış ve ev içi kullanıma uygun olmasıdır. İçme suyu arıtma

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tesislerinde kullanılan arıtma teknolojileri, ham suyun özelliklerinin yanı sıra arıtılmış suda bulunması istenen özelliklere bağlı olarak değişiklik göstermektedir. Saflaştırma işleminde kullanılan klasik yöntemlerden biri olan fiziksel, kimyasal ve biyolojik saflaştırma, çözünmüş organik madde karşısında yetersiz kalabilmektedir. Bu, bizi çözünmüş organik maddelerle mücadele için yeni yöntemler aramaya teşvik ediyor.

Anahtar Kelimeler: Aktif mikroorganizma, Arıtma, İçme suyu, Su arıtma.

1. Introduction

EM technology means the technology in which active microorganisms are used. EM is not a single type of microorganism, but a mixture consisting of a combination of various groups of microorganisms. It has a good and healthy effect on the entire environment live. When these microorganisms are examined, it is found that many of them are used primarily in food and health fields. It has been proven that the use of EM is safe for health in Japan and other countries within the framework of the conducted research. It is noted that it does not have a harmful effect even if it is drunk. In many countries, EM has a permit as a beverage. It is informed that it is also used in places requiring hygiene other than agricultural applications. EM Technology is applied in the fields of agriculture, livestock, fisheries, environment, and medicine. Active Microorganisms consist of groups of microorganisms that can live in both aerobic (oxygen-containing) and anaerobic (oxygen-free) environments.

EM is the abbreviated form of the term" Active Microorganism". EM consists of various types of microorganisms and is produced in its unique conditions by collecting from nature. It is a cocktail of microorganisms available on the market in the form of a brownish liquid. EM was developed by Teruo Higa is a Professor at Ryukyus University in Okinawa in Japan, at the end of the last century. The use of EM, which has been perfected by conducting intensive research on it, has become extremely widespread in the fields of agriculture, livestock, and the environment all over the world over the past 20 years [12].

Microorganisms on Earth are divided into three: Destructive (Degenerating) microorganisms, Constructive (Regenerating) microorganisms, and Opportunistic (Neutral or Opportunistic) microorganisms. Effective Microorganisms are, in general, constructive it belongs to the class of microorganisms. They prevent the decomposition (putrefaction or oxidation) of organic substances and cause fermentation. Thus, there is information that they make nature healthy and ensure the formation of many biologically active substances and antioxidant substances. It seems that incentives have been made for the technological use of EM to become widespread. Some claims about EM applications; include sustainable agricultural, industrial, health (farm animals, pets, and humans), odor control, waste management, recycling, environmental remediation, and eco-friendly cleaning [9, 15].

From the past to the present, the existing water resources are of great importance in the life cycle of both people and plants as living beings. To meet the demand for needed water, purification is especially important from a health point of view. In addition to conventional methods of purification for clean drinking water, various new methods are being studied. For this reason, water quality is important in the supply of drinking water to protect the ecosystem. Sustainability in water quality is important and studies are continuing. The use of biological treatment, especially micro-organisms, to improve the quality of contaminated water is effective and is widespread, as it causes lower capital and cost compared to chemical treatments. That is why in recent years, there has been an increasing interest in the use of biological purification techniques for water as the best alternative option environmentally and economically. EM technology is a low-cost alternative to improving water quality and has a very high potential to improve the chemical and physical properties of water. Through this technology, the improvement of contaminated and degraded water structures that revitalize aquatic life and eco-systems will certainly result in sustainable water resource management in the region concerned. In addition, the potential of EM to compose agricultural, livestock, natural agriculture, environmental management, construction, human health and hygiene, industrial and social activities have also been very well realized [1, 12].

EM was tested in wastewater treatment by mixing it with some types of fungus in a certain proportion. Different types of composted sawdust have been used as a microbial carrier, food, and enzyme source and support to improve the wastewater treatment process. It is aimed to improve the quality of treated wastewater and the resulting sludge here. The parameters of treated wastewater in terms of BOI, KOI, O&G, Total organic matter, and suspended solids have been greatly improved by 85.0 %, 79.0 %, 82.7 %, 74.6 %, and 87.7 %, respectively, according to the retention time and the type of materials tested [8]. Another study shows that EM technology has been applied in Vietnam to convert waste into organic fertilizer for the treatment of garbage and waste in landfills and to treat water with a high concentration of organic substances. In this study, the results of garbage analysis in the Thai Mo landfill and analysis of liquid waste from the garbage in the collection tank were investigated. A comparison of the components of the inlet and outlet water of the pollutant concentrations of activated sludge (with and without the addition of EM) before and after treatment was carried out. The conducted analyzes have shown that EM technology is very effective in environmental management in landfills. In another study, it is seen that good results have been obtained in the treatment time and efficiency by using EM in wastewater treatment that produces lincomycin [7].

Turkey has an important potential with its 8333 km coastline, 80791 km2 sea area, 10000 km2 natural lake, 15000 ha pond, 342377 ha dam lake, and 177714 km long streams surrounded by seas on three sides [11].

In our country, which has a rich water potential with streams, lakes, and dam lakes, the Çankırı province, the Kızılırmak Delta, and the Devrez Stream are important. Devrez Stream, formed by streams coming from Işık Mountain and Aydos Mountain, forms a long valley (Northern Anatolian Fault Line) that can be considered deep, continues its way from west to east and reaches Kızılırmak River at the end of its 211 km journey, emptying its waters into this largest river within the borders of Turkey. Devrez valley is divided into 3 parts, from west to east (in the direction of flow), Upper, Middle, and Lower Devrez. The flow regime of the Devrez Stream is quite irregular, in which the snow melts its flow rate exceeds 600 cubic meters/second in spring and can drop to 3 cubic meters/second in summer [6].

Water quality affects the composition, productivity, abundance conditions of species, and the physiological conditions of aquatic species. Dam lakes are affected by environmental pollution in the first degree because they show a constant receptive environment feature. This contamination not only negatively affects the living creatures living in it, but this negative effect affects every living species up to humans through the food chain [13]. Pollutants from domestic, industrial, and agricultural activities are first mixed into streams and again reach lakes and seas through streams. Therefore, the properties of waters obtained from natural sources and used in the production of aquaculture should be very well known and the balance should be maintained [11]. Water resources in the world are rapidly decreasing. Among these resources, water resources of drinkable quality have also decreased and come to the point of depletion. The problem of freshwater scarcity and pollution has been escalating globally for the past few years.

According to the data of the State Institute of Statistics, it has been informed that our population will reach about 84 million in 2025. In this case, it is said that the amount of available water per capita will decrease to 1300 m3 by 2025. Due to this situation, the importance of the right approaches in terms of water use and water resources is increasing more than once [2].

It has been estimated that two-thirds of the world's population may experience difficulties in accessing healthy water by 2025 [14]. In addition to its natural flora, water can also contain microorganisms found in soils and plants, and in case of contamination, microorganisms are found in feces and sewage waters. No matter for what purpose the water is used, it should not contain pathogenic microorganisms [5]. For this reason, it is necessary to treat the existing water resources so that they are not polluted and the water resources are used more efficiently [3].

2. Material and Method

Below are the analyzes working with raw water and EM and the devices used.

- ✓ pH, Conductivity, Dissolved Oxygen
- ✓ Turbidity analyzer NTU (Hach 2100 Q)
- ✓ NS. Hach lico 150 colorimetric colors (Pt-Co) analyzer
- ✓ D. Alkalinity (Titration)
- ✓ to. Mn, Fe, TC, TIC, TOC (Spectrophotometer)
- ✓ Phosphanate analyzer DRB 2800 Hach analysis spectrophotometer
- ✓ Total nitrogen analyzer DRB 2800 Hach analysis spectrophotometer

EM-5 (Microorganisms in it: Lactobacillus Plantarum, Lactobacillus Rhamnous, Lactobacillus Casei, Lactobacillus Delbrueckii, Figure 1).

Fig. 1. Example of EM Samples

In this study, EM was prepared with pure water in a ratio of 0.001. 5 mL of the prepared solution was taken and dosed into 500 mL of raw water taken from Güldürcek Dam. Every four days, 5 mL of the solution prepared with pure water is dosed into 500 mL of raw water. After 12 days, both physical and chemical analyzes consisting of 13 parameters were performed by taking the water remaining on the surface of the studied sample (Fig. 2).

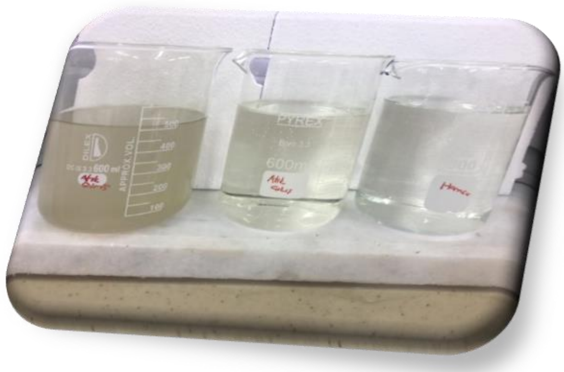

Fig. 1. Raw water from Güldürcek Dam after addition EM

3. Results and Discussion

Analysis results of raw water and EM added to water are given in Table 1. Measurement results have been compared by the standards.

Table 1. Properties of silica nanoparticles

Parameter	Standart	Raw Water	Raw water with EM*5
Temperature (˚C)		18.3	17.0
pH	6.8-8.5	7.6	9.0
Conductivity (µmhos/cm)	<2500	206.3	220
Dissolved O_2 (mg/L)		8.23	10.5
Blur (NTU)	0.4-1.0	3.1	

Color (Pt-Co)	1-20	11.0	9.0
Mn (mg/L)	0.02-0.05	0.09	0.03
Iron (mg/L)	0.05-0.2	0.10	0.05
PO_4 (mg/L)	2-20	0.09	0.0
Total Nitrogen (mg/L)	20-100	3.1	3.0
TC (mg/L)	12-75	129	111
TIC (mg/L)	10-73	42.1	47
TOC (mg/L)	2-65	87	64.2
Parameter	Standart	Raw Water	Raw water with EM*5
Temperature (˚C)		18.3	17

When the use of EM is evaluated according to the results given in the table; If we consider the temperature, since the working period is winter, the dam temperature is normally measured between 5-8 ˚C. However, the water taken from the dam and brought to the facility has reached room temperature of 18.3 ˚C. It has been observed that the temperature after adding EM decreases by one parameter, although it is kept under room conditions. It was found that the pH was low in the dam in recent months due to dissolved organic matter. The sample taken from the dam has a pH of 7.62 in the water. The pH measured in water with EM is 9.01. It has been found that pH increases in water with EM. It is seen that it slightly exceeds the specified range for Güldürcek Dam. Conductivity is an indicator of dissolved substances. In this study, the conductivity measured in raw water is 206.3. The conductivity measured in EM water was 220, an increase of 6.3 % was observed. Dissolved oxygen creates an anaerobic environment when it is low, and an anaerobic environment at normal values.

In the data obtained in this study, dissolved O2 is 8.23 in raw water. It was measured as 10.48 in water with EM, and an increase of 21.5 % was detected. This shows the way to the aerobic environment. It is undesirable to have it in drinking water since turbidity is an indicator of AKM. When looking at raw water, it was found that the turbidity was at 3.12, and when looking at the water with EM, it was found that this decreased to 0.99. This indicates a 70 % improvement in turbidity. Color is an indicator of contaminants. The color in raw water was found to be 11, and in EM water it was found to be 9, and an improvement of 18 % was observed. EM suppliers also argue that EM also reduces the value of heavy metals.

For this reason, a study of manganese and iron was conducted, and manganese was found to be 0.092 in raw water and 0.030 in water with EM, and an improvement of 67.4 % was found. If we look at the iron analysis result, it was 0.10 in raw water and 0.05 in EM water, and an improvement of 50 % was detected. Phosphonate is an agent that limits the population of phosphorus-deficient algae. In raw water, the phosphate was measured as 0.091, and in EM water it was determined as 0.075, a decrease of 17.6 % was observed. Nitrogen in raw water is an indicator of organic pollutants. The TOC in raw water is 128.8. It was 111.2 in EM water and a 14 % reduction was observed.

4. Conclusions and Recommendations

As a result, it has been proved that EM can be used as an auxiliary element in the fight against the dissolved organic matter. Also, when EM is evaluated in terms of cost and characteristics since oxygen consumption can be reduced, the operating cost will decrease, and since the water still contains EM microorganisms after purification, a great improvement in vegetation and the environment will be observed wherever it is discharged from the facility to nature. This improvement is the result of an improvement in the biological quality of water. The use of EM in water treatment comes across as an inexpensive technology that gives good and effective results.

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