

Development of the Process for Making Agricultural Cultivation Water from Seawater using Natural Zeolite

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ABSTRACT

We attempt to develop the process for making agricultural cultivation solution from seawater using natural zeolite. Mordenite-type zeolite obtained from Iizaka mine in Japan indicated highest reduction of Na^+ . Radish sprouts did not grow using seawater, the solution treated with natural zeolite, the solution treated with AgNO_3 after zeolite treatment, and the solution treated with natural zeolite after AgNO_3 treatment, due to the high contents of Cl^- and NO_3^- remained in these solutions. By combination of anion reduction treatment using calcined hydrotalcite and zeolite treatment, radish sprouts can be grown in the prepared solution.

KEY WORDS: Seawater; Agricultural cultivation water; Natural zeolite; NaCl reduction; AgNO_3 ; Calcined hydrotalcite; Radish sprout

INTRODUCTION

In the 21st century, the problem for energy and environmental conditions become more serious. The food crisis is one of the big problems that should be solved. Production of a stable supply of food is essential to sustain human life. Securing the agricultural water is one of the most important factors in the food production. However, recent environmental problems such as desertification of soil are major contributors to the decline in water resources for crops, and an increasing number of regions are having difficulty achieving a stable supply of food. During the 20th century, the global human population has increased fourfold, but the withdrawal of water from the natural freshwater resource has increased eightfold (Abdul, 2006).

On the other hand, effective utilization of resources is an important issue for the 21st century (World Water Council, 2002). One of the ways to supply for water resource is seawater desalination. In desalination technologies, multi-stage flash (MSF) or reverse osmosis membrane method (RO) is famous all around the world (Goto, 2000). In these desalination technologies, almost ions contained in seawater are removed, and make the fresh water high quality for domestic or industry. However, the amount of use for irrigation is the highest utilization for the fresh water in the world, and the percentage of irrigation in freshwater utilization is 70 % of the total freshwater utilization (Tilzer, 2006). As for the water used as agricultural water, it is desirable for the crops that the water contains element for crops rather than the high purity water. The water made by MSF or RO is

expensive for agriculture. Also, high purity water needs the addition of the fertilizer to apply for the agricultural field. Seawater contains the essential elements needed for plant growth, but its high concentration of NaCl causes salt damage that precludes its direct use. Therefore, it would be possible to produce the irrigation water from seawater by reducing the NaCl using a simple-process.

Here, we attempted a new simple process to reduce the NaCl concentration in seawater using natural zeolite. Natural zeolite occurs in natural deposits, generally associated with grassy volcanic rock, and is available in large quantities at low cost (Tominaga, 2001). Based on their high ion-exchange capacity, absorptivity, water retention and low cost, natural zeolites have been used in agronomy, horticulture and industry (Akgü, Karabakan, Acar and Yürüm, 2006). Therefore, natural zeolite can be used to reduce Na^+ in seawater by ion exchange at low cost, and reused repeatedly by ion exchange with other cations. Little information is available, however, on the treatment of seawater with natural zeolite. Additionally, more information is needed about anion removal treatment for Cl^- reduction to combine with natural zeolite treatment for making agricultural cultivation water.

In this study, we investigated the treatment of seawater by 5 types of Japanese natural zeolite, combinations of anion reduction treatment and then applied the prepared solution to the growth of radish sprout.

EXPERIMENTAL

Seawater and Samples

Seawater used in this study was collected from the surface layer in Imari Bay, Saga Prefecture, Japan (Fig. 1). Five kinds of Japanese natural zeolite, Iizaka-zeolite (IZ), Tenkawachi-zeolite (TZ), Koriyama-zeolite (KZ), Futatsui-zeolite (FZ) and Niki-zeolite (NZ) were used in zeolite treatment. IZ and TZ were mordenite-type zeolites, and KZ, FZ and NZ were clinoptilolite-type zeolites. The types of their natural zeolites were typical natural zeolite structures all over the world. The occurrences of these natural zeolites were shown in Fig. 1. The AgNO_3 reagent (Analytical grade, Wako) and commercially calcined hydrotalcite (CHT), KW-2000 (KYOWA KAGAKU KOGYO Co., Ltd.), were used in anion reduction treatment.

Natural Zeolite Treatment

We examined the treatment of seawater by 5 types of Japanese natural zeolite and compared the Na^+ reduction from seawater.

20 g of natural zeolite was added to 200 mL of seawater, and stirred for