Preventing Diarrheal Disease in Developing Countries: Simple Options to Remove Turbidity

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The health consequences of inadequate water and sanitation services include an estimated 4 billion cases of diarrhea and 1.9 million deaths each year, mostly among young children in developing countries. Diarrheal diseases lead to decreased food intake and nutrient absorption, malnutrition, reduced resistance to infection, and impaired physical growth and cognitive development. Since 1996, a large body of published work has proven the effectiveness of interventions to improve water quality through household water treatment and safe storage (HWTS) at reducing diarrheal disease. However, not all of these interventions remove the turbidity that causes water to look dirty. Although the following options are **not** proven to reduce diarrheal disease incidence on their own, they can be used to pre-treat water to reduce turbidity before the use of household water treatment products. These options mechanically (through filtration) or chemically (through flocculation and settling of suspended material) remove particles and reduce turbidity. These pre-treatment methods may also increase the efficacy of household water treatment products by removing contaminants that interfere with disinfection and physical filtration processes. For more information, contact safewater@cdc.gov.

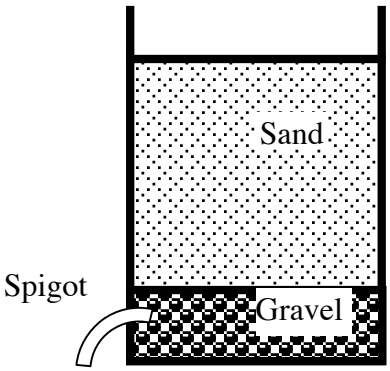
Cloth filtration in Kenya (CDC, R. Quick)

Cloth Filtration

A simple option to pre-treat turbid water is to filter through a locally available cloth. Users pour water from the transport container through the cloth into the storage container. The benefits of this option include its simplicity, the wide availability of cloth, and the fact that filtration through multiple layers of sari cloth has been shown to reduce cholera transmission in Bangladesh by removing the copepods to which the cholera bacteria are attached. Drawbacks of this option are that the filtration capacity of cloth varies greatly, and filtering through multiple layers of cloth can be very slow. In laboratory studies, the use of cloth filtration reduced the turbidity of water, but did not reduce its chlorine demand, the amount of chlorine that is used up by organics before disinfection can occur.

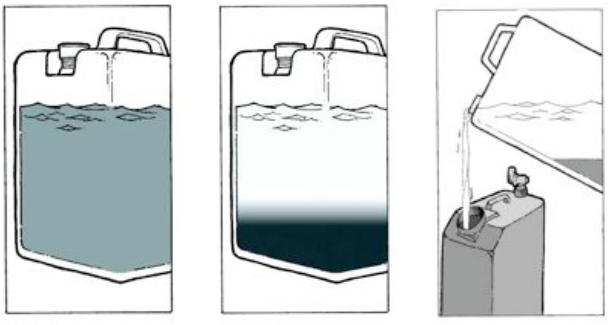
Sand Filtration

Filtration through clean sand is a fast and simple pre-treatment option. Users pour water from a transport container through a container of sand with gravel and a spigot at the bottom. The water then flows into a storage container. The benefits of sand filtration are that it is effective at removing some bacteria, it is simple and fast for the user, and, if sand is available locally, it is inexpensive. The drawback of sand filtration is that it requires three containers and a spigot. In laboratory studies, the use of sand filtration significantly reduced both the turbidity and the chlorine demand of turbid water.



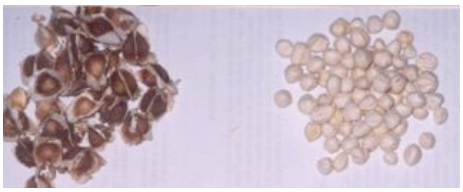
Simple Sand Filter Design

Turbid water *Settling* *and Decanting*



Settling & Decanting

Settling and decanting is a method to reduce turbidity by letting the water sit for 2-24 hours so that the particulates settle to the bottom of the container. The clear water is then decanted off the top into a second container. The benefit of settling and decanting is that it requires no equipment besides the containers. The drawbacks of settling and decanting are the need for multiple containers, the time it takes the water to settle, and, if the containers are opaque, the difficulty in observing the effect of settling. In laboratory studies, the use of settling and decanting significantly reduced both the turbidity and the chlorine demand of turbid waters.



A moringa tree with pods
Shelled and unshelled seeds

Ground seeds
(CDC, D. Lantagne)

Moringa Flocculation

The moringa tree pod contains a seed, which when crushed, is a natural flocculant. Users pick and dry the pods, and then remove the seeds. The seeds are shelled, crushed using a mortar and pestle, and about 2 grams of the seeds are added to 20 liters of water. The water is stirred for five minutes, and users let the water settle for 24 hours before decanting it off into another container. The benefit of moringa is that it is an effective flocculant. The drawbacks are that it is time- and labor-intensive, the dosing of moringa varies for different water, two containers are required, and the moringa flavor may be objectionable. In laboratory studies, the use of moringa significantly reduced the turbidity of water, but also significantly **increased** the chlorine demand of the water because of the additional organic material. The use of moringa is not recommended in conjunction with chlorine-based disinfectants.

Raket Flocculation

In Haiti, the cactus raket contains a natural flocculant. Users pick the raket, cut it diagonally to expose the maximum flesh surface area, add the raket to the water, stir briefly, and wait ten minutes before straining the water through a cloth. The benefits of raket are that it is effective at removing turbidity, and that raket is widely available in Haiti and easy to prepare. The drawbacks of raket are the need for two containers and that the three-step procedure of raket preparation, addition, and cloth filtration is complicated for the user.

Stirring water and racket; Filtering through a cloth
(CDC, D. Lantagne)

An alum chunk
(CDC, D. Lantagne)

Alum Flocculation

Aluminum sulfate is widely used as a flocculant in water treatment plants in the United States and Europe. It is also widely available in developing countries, sold in naturally occurring mineral blocks of soft white stone, and generally called ‘alum’. There are numerous ways to use alum as a flocculant, including crushing it into a powder before adding it to water, stirring, and decanting; or, stirring the whole stone in the water for a few seconds and waiting for the solids to settle. The benefits of alum are that it is widely available, is proven to reduce turbidity, and is inexpensive. The drawbacks of alum are that the necessary dosage varies unpredictably, it can change the pH of the treated water, and using too much leads to a salty, unpalatable taste. In laboratory studies, the use of alum significantly reduced the turbidity of water, and also significantly reduced the chlorine demand of turbid waters.