Water is life

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Abstract

Drinking clean water from the water tap at home is something we in Denmark take as a matter of course. But this is not something that you are able to everywhere in the world. So why are we this good at cleaning our drinking water? We want to investigate the Danish drinking water, and why it is this clean. What is the background to this effective way of cleaning our drinking water? Can we keep it this way and how is that possible? Maybe there is a way to make it even better than it is. We are going to investigate which kind of tests that are made to check if the water is clean enough, and the differences between purification plants might be. We do expect that there should be no difference between the different purification plants in our local environment. There are most likely rules about pollution of clean water. We want to find out what they are, and what they mean to maintain the clean water. To this there are some political aspects, which we want to include to our project, and we want to interview some experts to know more about the clean drinking water.

1 Introduction/Purpose of investigation:

The Danish tap water is usually obtained from groundwater, in exceptional cases surface water from remote lakes are used as a supplement, especially in the larger cities. To analyse and compare the water quality of groundwater to surface water we have analysed the presence of bacteria in a small public lake close to Vordingborg. It should be stressed that this lake is not used as drinking water. One way to reduce the level of bacterial contamination is to add chemicals, such as chlorine or to use UV to treat the water. As chlorine adds a very unpleasant taste to the water we have propagated bacteria in surface water before and after UV treatment.

1.1 Interview

In a small place near Vordingborg you will find a nice little office. Here in this office we met Erik Rasmussen MSc (Master of science) and his co-worker Birgitte Steen Jørgensen, who is a member of local authority council. Mr Rasmussen and Mrs Jørgensen both are working with the water in our community. We asked them some questions about clean water in our local area. The first question we asked them was what kind of rules there are about the quality of the water. To answer that, Mr Rasmussen told us, that EU has made some rules that every country has to follow. The rules from EU are directly translated to Danish law giving. Those rules are overall rules and they are used different depending on the local environment and climate. We also asked what kind of chemicals and how often do we have to register the amount of it. The types of chemical analyses are divided into groups. There are 4 different types of bacteria analyses. These tests are chosen depending on situation and how much money there is for the test. The Basic test includes smell, colour, and pH-factor. This is a relatively inexpensive. Permitted limits are given about these different factors. Other than that there is the simplified control. The simplified control involves a well in the country. This control is testing the water for lead, copper, nickel and quicksilver. The simplified control includes the factors from the basic test. Tests and controls can be improved and expanded by adding more chemicals to the control.

The large waterworks have to test for a lot of chemicals in the water, while smaller waterworks only have to test for specific group of chemicals. This is done because of economic reasons. They should all be able to pay for these expensive tests.
Every fourth year the water is tested by the drillings (where the water is totally “new” from the underground). The test shows how the pure water in the underground is, and what chemicals it contains. In the underground there are no bacteria’s, but metallic and nutrients do exist here (ammonium and nitrite à fertilization). The waterworks are able to turn nitrite into nitrate. Humans are not able to consume nitrite, but when it is nitrate we can consume it well.

There are different limited values for the chemicals in the water that we drink. One very important limited value is, if it is harmful to health. Is the chemical toxic enough to kill one person in one year out of a million people then the risk is pretty small. It makes no sense for the community to spend so much money if the risk is this low.

Particularly for the community of Vordingborg is, that we extract our drinking water from calcium. On the soil there is a lot of clay and gravel, and beneath that, we find the calcium about 70 metres deep down. When extracting the water from the calcium there must be done some specific tests. These tests are testing for some specific chemicals. There are some spectacular conditions in the community of Vordingborg, but EU sets the overall rules. Water is extracted from the countryside, because water here is cleaner. The water

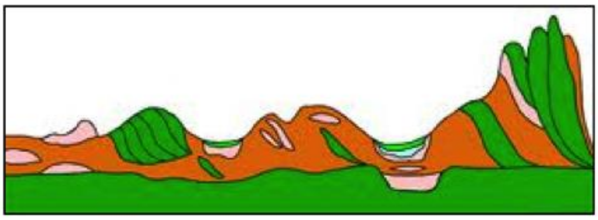
near the cities is often more polluted than the water on the countryside and it is also cheaper to extract the water from the countryside.
A few waterworks takes test samples from underground "pockets of sand". These tests are cheaper. With these tests you have to be attentive about nitrate and nutrients (difficulties with nutrients). 4-million m^3 water goes out to the community of Vordingborg and about 2 m^3 for the town of Vordingborg.

1.2 Particularly for Denmark

In Denmark we are able to use groundwater, which is special, compared to other countries in Europe. We are using ground water. Many other countries are extracting their drinking water from surface water. The groundwater in Denmark is about 500-1000 years old. The rules, given by EU, do not always fit perfectly to our circumstances. The reason is that there are a lot of countries in EU using surface water.
The groundwater does not contain oxygen and it has a different chemical composition than surface water has. When water comes up from the ground it precipitates calcium and other stuff, and this is not really good. That is why we extract water from the underground.

1.3 The Danish Groundwater

The Danish groundwater is very different from other countries´ groundwater. The special thing about Denmark is that it is built on a platform of chalk. The chalk is made through millions of years by alga with shells made of chalk. The shells have deposited on the bottom of the sea and created a thick layer of chalk. In the community of Vordingborg there is a spot about 128 metres about the water. Being on top of these cliffs, called Møn´s Cliff, makes you stand directly on the Danish chalk fundament. The layer of chalk is about 60 metres deep. Through the landscape the layers of chalk lay down under the ground. Møn´s Cliff is a great way to see and study the layers of chalk beneath the Danish ground.



The picture above shows the typical landscape in the community of Vordingborg by Møn´s Cliff. Green colour represents chalk. The brown colour represents clay and the light pink spots are sand. This picture is borrowed from Mr Rasmussen and Mrs Jørgensen.

http://www.moensklint.dk/geocentermoensklintdk/generel-info/huset.aspx

The picture above is of Møn´s Cliff. It shows thick layer of chalk and how it colours the sea.

The huge amount of chalk makes the groundwater contain a lot of Ca-ions. This is seen as the water precipitates chalk when it is getting into machines or water taps. This does bring some difficulties along with it. The natural chemicals in the groundwater from places where there is a lot of chalk have to be removed. These chemicals are chloride, fluoride, methane and hydrogen sulphide.

1.4 Waterworks in Vordingborg

Following fact box contains facts about the goals for the water extractions of the waterworks in the community of Vordingborg.

VORDINGBORG KOMMUNE

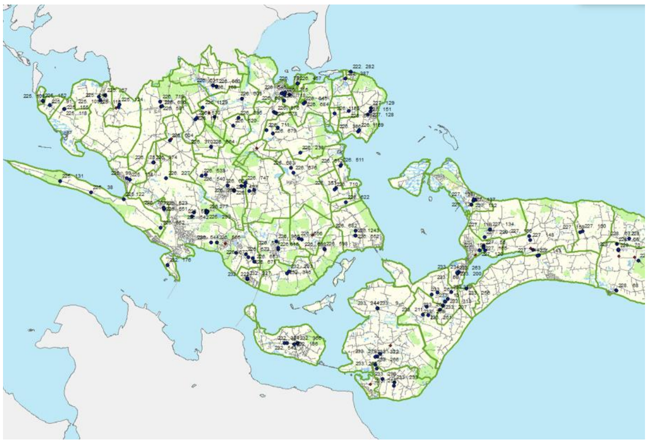
- The drinkingwater resources must be protected and used properly in the environment
- The citizens in the community of Vordingborg receive water of great quality
- The drinking water must be based on clean groundwater that has been watertreated
- There should not be extracted more groundwater than necessary
- There should be a balance between extracted water and the production of groundwater in the ground
- The extraction points of groundwater have to be spread out on the country, respecting nature and the quality of the groundwater
- The groundwater cannot be threatened by pollutions

or the fact that there are too many extraction points

- Areas with groundwater that is useful as drinking water must not be used for activities that causes pollution

http://www.vordingborg.dk/kommuneplanen/land-og-vand/grundvand/vandindvinding/

The visions of Vordingborg about groundwater and water extractions are great. The community of Vordingborg has large ambitions and the quality of our drinking water and groundwater is high.



The picture above illustrates water extractions in the community of Vordingborg. This picture is borrowed from Mr Rasmussen and Mrs Jørgensen.

1.5 Permitted Limits

Parameter	**Parameter permit limit**	**Unity**
Copper	2,0	mg/l
Fluoride	1,5	mg/l
Quicksilver	1,0	µg/l
Nickel	20	µg/l
Nitrate	50	mg/l
Nitrite	0,50	mg/l
Pesticide	0,10	µg/l
Aluminium	200	µg/l
Chloride	0,50	mg/l

Oxygen consumption	5,0	mg/l O_2
Sulphate	250	mg/l
Sodium	200	mg/l
Coliform bacteria	0	Number/100 ml
pH	$\geq 6,5$ & $\leq 9,5$	pH - unity

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1998:330:0032:0054:DA:PDF

The table above shows some of the permitted limits given by the EU rules.

2 Experiments

3 Experiment 1

Test description of experiment with water samples:

3.1 Materials

600 µl water from the tap at the toilet

600 µl Water from the water dispenser (UV irradiation)

6 sterile Petri dishes with LB agar (liquid nutrient for the bacteria)

2 control samples (sterile Petri dishes with LB agar without water sample)

Incubator (about 30 degrees)

Drigalski spatula

3.2 Hypothesis

We expect that there may be fewer bacteria in the UV-irradiated water from the water dispenser, than in the water from the tap at the toilet. We expect this, because there is a higher focus on promoting the cleanliness of the water from the water dispenser, than the water from the tap.

3.4 Procedure

- Take a sample from the tap at the toilet and a sample from the water dispenser
- Store the samples in sterile containers
- Set up two control plates with agar, without water samples
- Put 200 µ from the water dispenser sample on three of the plates (200 µ on each)

- Sterilize a drigalski spatula
- Use the drigalski spatula to distribute the water sample on the agar
- Put 200 µ from the tap sample on three of the plates (200 µ on each)
- Sterilize a drigalski spatula
- Use the drigalski spatula to distribute the water sample on the agar
- Place the 6 plates with water samples (+ the two control plates) in a incubator

3.5 Finishing

Subsequently, compare the water quality and the content of bacteria in the water, to see if the UV-irradiated water contains fewer bacteria than the water from the tap.

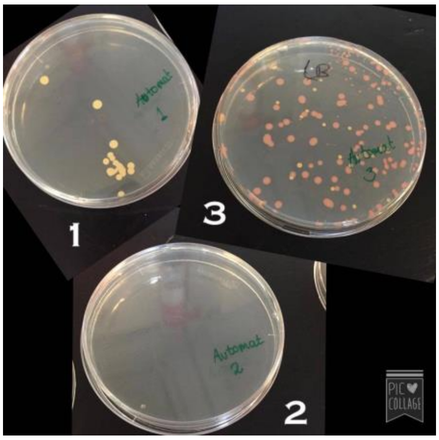


Fig.1 Water dispenser day 5

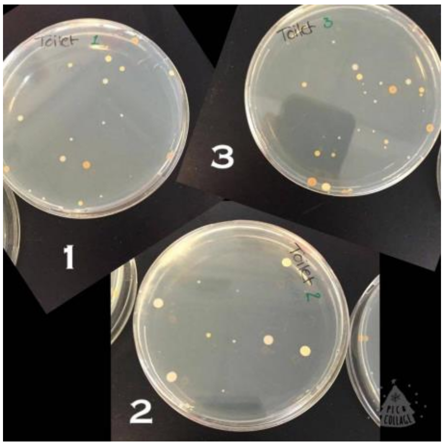


Fig. 2 Water tap day 5

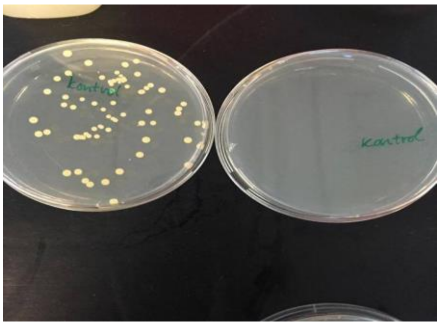


Fig. 3 Control day 5

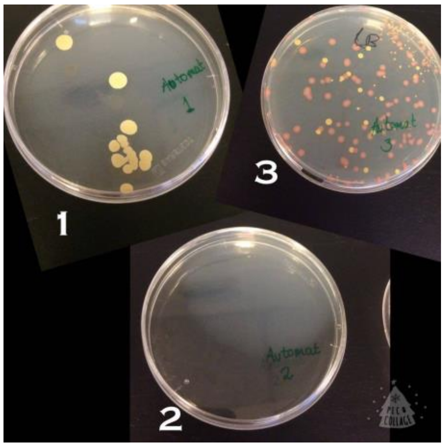


Fig. 4 Water dispenser day 8

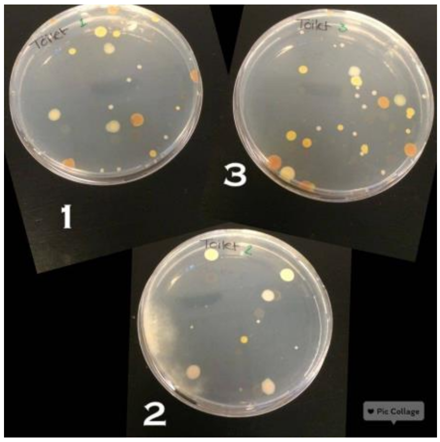


Fig 5. Water tap day 8

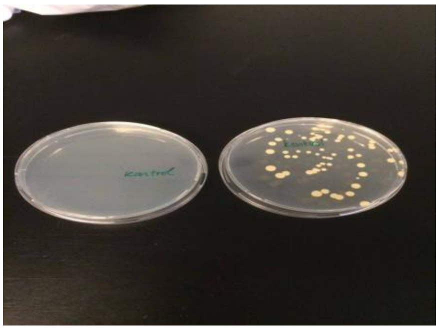


Fig. 6 Control day 8

4 Experiment 2

Test description of experiment for determination of water quality:

4.1 Materials

Water sample from the Hulemosesø (0,5 litre)

6 sterile Petri dishes with LB agar (nutrient for the bacteria)

2 control samples (sterile Petri dishes with LB agar without water sample)

Incubator (about 30 degrees)

UV-pen

Drigalski spatula

Fig. 7 On the picture above, you can see the UV-irradiated water.

4.2 Hypothesis

We expect that UV-irradiation of the water, will reduce the bacterial centent, and the water will be more optimal for drinking water.

4.3 Procedure

- Store the water sample in a sterile container
- Set up two control plates with agar, without water samples
- Put 200 µ from the water sample on three of the plates (200 µ on each)
- Sterilize a drigalski spatula
- Use the drigalski spatula to distribute the water sample on the agar
- UV-irradiate 200 µ of the water sample
- Put the UV-irradiated water on 3 of the plates (200 µ on each)
- Sterilize a drigalski spatula
- Use the drigalski spatula to distribute the water sample on the agar
- Place the 6 plates with water samples (+ the two control plates) in a incubator

We have taken some pictures where we are able to see some test results from our experiment.

Fig. 8 UV-irradiated lake-water

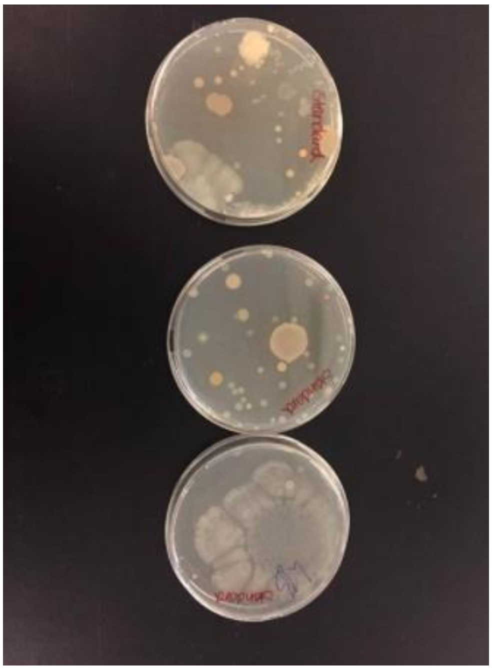


Fig. 9 Regular lake-water

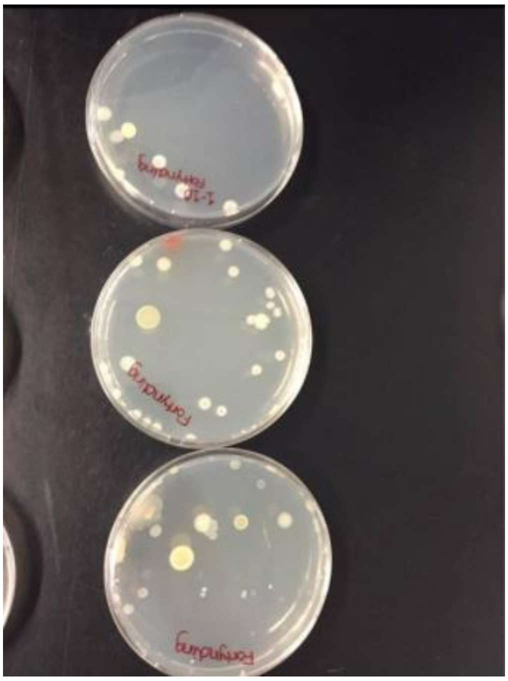


Fig. 10 Diluted lake-water

We are able to see the differences between the UV-irradiated lake-water and the normal lake-water. When you irradiate water, some of the bacteria will pass away, but others are able to have better conditions.

4.5 Finishing

After the experiment, compare the bacterial content of the untreated water sample and the UV-irradiated water sample.

- UV irradiating works by cutting the DNA into smaller pieces. This is the reason why some of the bacteria in our experiment died.

5 Conclusion

In this project, we investigated the quality of the water in our local area in Denmark. We knew that the water at our school was UV-irradiated and because of that, we wanted to investigate the effect of this. After our experiments, we discovered that the UV-irradiation removed some bacteria, but not all, which allowed the remaining bacteria to spread. We got the same results when we used water from a lake, which confirmed our fist experiment.
We can conclude that the UV-irradiation does not remove all of the bacteria, as we expected, only some of them. This also shows that the water from the water dispenser is not really any better to drink, than the water from the tap at the toilet. Also we can conclude that the UV-irradiation has a big effect on the water from the lake, which makes it more drinkable, actually the water from the lake contains less bacteria than the water at the school after the UV-irradiation.