

AUTHOR'S INFORMATION ON DOCTORAL (Phd) THESIS

NATIONAL
UNIVERSITY OF PUBLIC SERVICE
Council of Doctors

KRISZTINA TAKÁCS

**Development opportunities for water supply, with a focus on a microbiological water
rating**

doctoral (PhD) thesis
author's information and formal avaluation

Budapest

2020

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Dissertation supervisor:

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BUDAPEST, 2020

DRAFTING OF THE SCIENTIFIC PROBLEM

Due to Hungary's geographical location and geological endowment, it does not struggle with water scarcity, and surface and groundwater bodies can continue to meet the needs of industrial and residential water needs with professional and forward-looking management. However, during the extremely warm summers caused by global warming, water shortages may occur in Hungary as well, in which case the supply of the population may be disrupted. Experience to date has shown that the system was able to deal with water consumption problems on the hottest summer days with minor restrictions while making maximum use of drinking water abstraction sites. A possible extraordinary event - an accident related to hazardous substances, an industrial disaster - during which a hazardous substance is released into the environment poses a serious threat to drinking water supplies. At the same time, a serious flood or flood-like rain can be a danger, during which rising water can also release wastewater into the environment, which is a serious source of biological danger.

If environmental pollution occurs, the tests shall be extended to the surface waters around the drinking water base and to the soil, exposed to the type of pollution. This allows the path of contamination to be traced.

It is essential to produce the right quality and quantity of drinking water for everyday life. Ensuring the water supply also includes regular inspections of drinking water to ensure that water of impeccable quality reaches consumers. 201/2001 on the quality requirements for drinking water and the control procedure (25.10.) Contains the frequency of sampling and the names of the microorganisms to be detected in the water during each test and the various standards according to which the tests have to be performed.

The microbiological testing methods used in Hungary for water testing, prescribed by regulations, are extremely time-consuming, and both sample preparation and incubation time take a lot of time. Some tests can take several days. However, there are test methods that are already widely used abroad that can shorten these test times.

Therefore, the scientific examination of these procedures and thus the creation of adaptation possibilities in Hungarian practice is an important task, as all these are of great importance in an unexpected catastrophic situation, water pollution, when the necessary measures can be taken sooner and damage elimination is more efficient. and it will be faster.

OBJECTIVES OF THE RESEARCH

The basic goal of my research is to formulate proposals for the application of new microbiological water testing procedures in the Hungarian institutional system, disaster

situation and field conditions, based on the evaluation of the results of my own laboratory tests based on scientifically based ones. After performing laboratory tests, my goal is to formulate a new test protocol for bottled mineral waters.

In my dissertation, I intend to make a comparative analysis that helps to select the appropriate water testing procedure in a given situation by examining various parameters.

I formulated my research objectives in connection with the protection of drinking water bases, the provision of a continuous water supply and the appropriate water quality:

- to review the general characteristics of drinking water, including bacteriological characteristics, the range of water users and the requirements for ensuring water supply, and identify and analyze the risks that may affect water quality;
- to search for and analyze water testing methods used in the military sphere, comparing them with the protocol used in civilian life;
- to analyze technical-specific descriptions, regulations, protocols and available foreign sources related to water tests, on the basis of which the requirements for systems and procedures become clear;
- starting from the complex environmental safety, conducting targeted experiments and examining the possibilities of domestic adaptation, to take into account foreign test methods and results;
- using the results to make a recommendation to adapt the applied methods to the Hungarian institutional and activity systems.

RESEARCH HYPOTHESES

Based on the research objectives, I set up the following hypotheses:

1. I assume that in the course of a scientific approach, by testing the microbiological methods applicable to the testing of drinking water according to my own system of criteria, I can select the method that best supports disaster situation application.
2. In my opinion, the microbiological water testing methods used in Hungary are not the most optimal in terms of testing parameters, so I assume that several methods may be suitable for adaptation to the Hungarian organizational and institutional system during the comparative examination of the methods available in Hungary.
3. In my opinion, due to the changes in drinking water consumption habits, it is necessary to tighten the microbiological parameters for bottled non-carbonated mineral waters, which I intend to support with laboratory tests.

4. To my mind, IDEXX type tests suitable for the examination of the microbial status of drinking waters may also be suitable for the microbiological examination of living waters, which I intend to prove by practical laboratory tests.

RESEARCH METHODS

I conducted my research using several research methods to prove or disprove the defined objectives and the hypotheses set up.

- In some of my research I used general research methods, such as analyzes, inductive and deductive methods, and research synthesis. I studied and processed the relevant Hungarian literature, as well as the valid legislation and specific regulations.
- As a specific method, I performed laboratory microbiological tests, the results of which were evaluated in a complex way.
- I participated in national and international conferences and professional lectures, and in addition I held consultations with experts in the field, who helped to elaborate my dissertation by presenting the contexts of their own fields.
- I regularly published my partial research results in the relevant Hungarian professional journals, and I also participated in Hungarian conferences to present my topic and some of my researches.

A BRIEF DESCRIPTION OF THE PERFORMED EXAMINATION BY CHAPTER

In my dissertation, I first presented the water of drinking water bases as an environmental element and an essential pillar of our lives. In addition to the various properties of water, I described the requirements necessary to ensure the supply of water, the conditions of the consumability of drinking water, including the biological risks causing the deterioration of water quality. I examined the development of drinking water and mineral water consumption habits and elaborated on how to implement an adequate water supply in military camps. I have shown what options are available under camp conditions to produce and store, transport and package the appropriate drinking water as needed.

In the second chapter of the dissertation I described the legal background of water management and water base protection. I have shown what are the risk factors that can negatively affect water safety. I explored and collected the procedures and water treatment methods that can guarantee the proper water quality. During the presentation of the current environmental safety risks, I highlighted the critical points and factors where special attention must be paid to

maintaining the proper microbiological condition of the waters. I have outlined the damage prevention tasks to be performed by professional bodies, disaster management and military specialists in the event of extraordinary or unexpected water pollution. I have described the stages of water quality remediation in different situations.

In the third chapter, I presented the process of drinking water testing, searched for and analyzed the specialist-specific descriptions and regulations related to water testing, on the basis of which the requirements for the procedures became clear. Based on this, I collected and systematized the microbiological methods and procedures suitable for water testing in Hungary. Taking these methods into tabular form, I developed a weighting system, taking into account the various factors related to the studies, with the help of which we can facilitate the task of the specialists in the selection of the method in each situation. In addition to civilian investigations, I scrutinized the actions of military units in cases where a disaster or emergency situation develops. I described the water testing methods used at the Hungarian Armed Forces, highlighting the possible shortcomings.

In the fourth chapter, starting from the complex environmental safety, I conducted targeted experiments and presented the results of my own laboratory tests. Using the experience of my own questionnaire survey, I presented the water consumption habits of the Hungarian population. In connection with this, I performed microbiological tests on commercially bottled natural mineral waters, where I found that the legal provision on mineral water is incomplete, and I proposed to revise and supplement it in my dissertation. Several laboratory experiments were aimed at assessing the quality of drinking water in the city of Győr, during which I presented and analyzed the results of water samples taken from specific places. I also carried out studies on the fact that the IDEXX method, which can be used in practice for drinking water testing, can also be used to assess the microbiological status of surface waters.

SUMMARY CONCLUSIONS

One of my main conclusions is that special attention have to be paid to ensuring the adequate supply of water even today, as the aim is to provide the consumer with water of the right quality and quantity from the point of view of public health. Ensuring the quality parameters of drinking water is the task of drinking water supply service providers in maintaining water safety, be it piped drinking water or mineral water. However, this also includes good consumer behavior for both types of drinking water, both during storage and during consumption.

I consider it important to carry out full-scale water tests at specified intervals, as this can also detect substances in the water that are not subject to the relevant legal requirements, but their

presence can cause damage to the health of water consumers. Analyzing the development of consumption habits, I concluded that natural mineral water is becoming more and more popular, therefore special attention should be paid to ensuring their proper storage conditions.

In my opinion, it would be necessary to clean and disinfect the water networks at regular intervals, which would be the responsibility of the service provider, and due to the conscious consumer behavior of the population, it would be necessary to regularly disinfect the domestic distribution network.

I came to the conclusion that we need to pay special attention to both the provision of drinking water to the population and the drinking water supply systems of military camps. Like the civilian service systems, the latter must be built in compliance with the relevant regulations, but local and military specifics and requirements must also be taken into account. Most often, mobile water purification equipment is used that is capable of producing drinking water of adequate quality for soldiers. In addition, all of this can be vital in the event of various disasters where waterworks are damaged and unable to provide an adequate water supply to the population.

I came to the conclusion that in many cases biological factors, most of all bacteria, are responsible for the unfavorable development of water quality. Therefore, regular monitoring of water bases is an important task, which also includes the detection of microorganisms, as their proliferation in water can also pose a threat to human health.

In order to fully meet my research objectives, I have explored and collected the procedures and water treatment methods with which we can filter out or, if necessary, inactivate the contaminants and microorganisms in the water, in order to contribute to guaranteeing the appropriate water quality. During the presentation of the current environmental safety risks, I highlighted the critical points and factors where special attention must be paid to maintaining the proper microbiological condition of the waters.

In order to make it easier to apply, I have collected and systematized the microbiological water testing methods and procedures used in Hungary. I have presented these in a table and, taking into account various practical factors, I have developed a weighting system, with the help of which I can facilitate the task of professionals in each situation regarding the selection of the method.

Comparing the individual microbiological water testing methods, I came to the conclusion that although the IDEXX methods are not yet widespread in Hungary - this may be because they are relatively expensive compared to other methods - their great advantage over traditional culture methods is that they get results in a significantly shorter time. . With these procedures,

the results can be evaluated within 1 day, gaining significant time over traditional methods. An additional advantage of the practical application of this method over the PCR method, for example, is that it allows accurate quantification, so that the treatment of microbiological contaminants and the disinfection of the affected areas can also start earlier. As a result, the further spread of infections can be reduced or even eliminated.

I compared the regulations for drinking water and mineral water, and I also performed a laboratory analytical test. I analyzed the results of the microbiological examination of the carbonated and non-carbonated mineral waters from my trade. The non-compliance of the challenged samples was mostly due to the high number of sites, for which the legislation only requires an inspection within 12 hours after bottling.

During the experiments, I came to the conclusion that the microbiological condition of bottled non-carbonated mineral waters is not adequate in all cases. 65/2004 on the regulation of natural mineral waters. (27.04.) FVM-ESzCsM-GKM joint decree is not strict enough from a microbiological point of view, as it only contains regulations for the bottling period. For this reason, I propose to include in the regulation the establishment of microbiological limits for natural mineral water for the entire period of the shelf-life. By extending this test, the suitability of commercial mineral waters for food safety can also be guaranteed.

In the course of my research, I came to the conclusion that several factors must be taken into account when selecting the appropriate water testing method. In connection with this, I used a SWOT analysis, with the help of which I described the factors that in some cases can even act as obstacles during the investigations. Knowledge of these is essential in order to apply the best method in a given situation.

I also highlighted the fact that the regulations requiring water tests are incomplete and do not give professionals a choice between methods. In conclusion, based on the laboratory tests performed by me, it is expedient to incorporate the IDEXX method into Hungarian practice due to its many advantages, as this method can be used not only for drinking water, but also for safe surface water. These studies are also significant because the bacteria found in our surface waters, especially in rivers, act as catalysts, so the change in their numbers means that some stress has affected the water base.

NEW SCIENTIFIC RESULTS AND THESIS

1. During laboratory experiments I tested methods suitable for microbiological testing of drinking water, during the analysis of the results I proved that taking into account the test parameters, the fastest IDEXX (chiller, pseudoaer, etc.) method is suitable for fast

and accurate detection of microorganisms in a disaster situation. information can be provided to decision-makers as soon as possible in field conditions.

2. By comparative analysis of the methods and tests applied to the microbiological water testing procedure available in Hungary, I proved that the microbiological water testing methods presented in Chapter 3 of my dissertation can be organically adapted to the Hungarian organizational and institutional system, I worked out the possible steps to integrate them into the system.
3. I proved by laboratory testing that the microbiological condition of non-carbonated bottled mineral waters deteriorated significantly during storage, therefore I developed a draft urging the introduction of a corrective measure to reduce the risks during the operation of the current system. This procedure can reduce microbiological deficiencies during the storage and transport of bottled mineral waters, thus guaranteeing adequate food safety.
4. I proved with practical experiments that the IDEXX (colilert, pseudoalert) method tests, which are basically prepared for the microbiological examination of drinking water, are suitable for assessing the microbial status of living waters when using appropriate dilution. After validation, comparing the results with the traditional culture method, I proved that the results are within tolerance, but the IDEXX method is significantly faster in time.

PRACTICAL USE POSSIBILITIES OF RESEARCH RESULT

In the course of my examinations included in the dissertation, I sought answers to remarks and shortcomings in the drinking water supply and drinking water examinations, which are not properly regulated in the Hungarian guidelines and regulations. The application of these observations in disaster situations and laboratory conditions results in a more efficient, dynamic water testing method. They can be used, among other things, in the field of disaster management, in emergency water tests, and in environmental official measurements. The implementation of my research results can be linked primarily to risk analysis.

I examined the microbiological methods suitable for water testing in a complex way and developed a multi-aspect weighting system, which makes it easier to select the most appropriate method for the given conditions in each situation.

With the measurements I tested in practice and confirmed by test results, I pointed out that in addition to the water testing methods prescribed in the standards, other methods are suitable for assessing the microbiological status of both drinking water and natural waters in a shorter time.

I drew attention to a fact about natural mineral waters that was not properly articulated in the legal background. Failure to do so may involve serious risks. In the case of bottled mineral waters, there is no satisfactory regulation over the entire shelf life, which may pose microbiological and therefore food safety risks. By creating an appropriate and comprehensive regulatory framework for all parameters, the achievement of healthy and safe bottled mineral waters in trade could be guaranteed.

In my conclusions, I proved that it would be expedient to establish and operate a mobile, installable water treatment plant, which would provide effective assistance in the event of a disaster, water pollution, even in the event of a planned or unexpected water supply failure or disruption. This would solve the uninterrupted supply of drinking water to the population in all circumstances.

The individual chapters and topics of the dissertation, and most importantly the individual sub-conclusions, are also suitable for the function of disseminating knowledge and informing the public, with which the consumer awareness can be increased.

RECOMMENDATIONS

I recommend the results formulated in my PhD dissertation primarily to the attention of legislators. The results of the research and studies conducted in my dissertation can also help in addition to the guidelines and regulations currently available. My remarks can serve as a basis for reviewing and revising existing legislation and regulations.

I recommend the application of the procedure described in my dissertation to all those persons and laboratory workers who deal with water quality testing, drawing attention to the fact that newer types of microbiological water testing methods are given priority over traditional tests. After all, in addition to drinking waters, these procedures can also be used effectively in the examination of surface waters.

The material of my dissertation can be a useful aid for professionals working in the field of environmental protection, disaster management and national defense, who are involved in the process of water pollution investigation, elimination and remediation.

Due to its practical applicability, my dissertation can be a useful aid for water utility service providers and official laboratories to make the right choice of microbiological water testing methods.

My dissertation provides an excellent basis for participants in specialized higher education and further training. I recommend my dissertation for further research, as my research serves as a good starting point for the topic.

LIST OF THE AUTHOR'S PUBLICATIONS ON THIS SUBJECT

Proof-read articles in periodicals:

- Krisztina Takács: Analysis of microbiological methods applicable to water testing in our country. *Hadmérnök* XV:(1) pp. 221-231 (2020)
- Krisztina Takács, Rajmund Kuti: Extrém esőzések következtében kialakult csapadéktöbblet kezelésének tapasztalatai Győrben (*As a result of extreme weather phenomena, the experience of treating excess rainfall is generated in Győr*), Országos Települési Csapadékvíz-gazdálkodási Konferencia tanulmányai, Budapest, Dialóg Campus Kiadó, pp. 288-295. (2019)
- Krisztina Takács: Protection of water based and water abstraction sites in Hungary based on studies in Győr. *Hadmérnök* XIV:(1) pp. 192-203 (2019)
- Krisztina Takács: Marcal folyó mikrobiális állapotának vizsgálata a vörösiszap katasztrófa tükrében (*Testing the river Marcal microbiological status in the mirror of the red sludge catastrophe*), *Hadmérnök*, XIII:(3) pp. 290-305 (2018)
- Krisztina Takács: Ivóvízellátás biztosításának típusai és annak biztonsági kérdései (*Types of drinking water supply ensure and this safety questions*), *Hadmérnök*, XIII:(2) pp. 315-325 (2018)
- Rajmund Kuti, Galina Horváth, Krisztina Takács: ФАКТОРЫ РИСКА ПРИ ЭКСТРЕМАЛЬНЫХ ПОГОДНЫХ УСЛОВИЯХ В ВЕНГРИИ, “СИСТЕМЫ БЕЗОПАСНОСТИ – 2017” (ISSC 2017): МАТЕРИАЛЫ, ISSN 2305-6711, Двадцать шестой международной научно-технической конференции, p. 440.
- Krisztina Takács: Győr város ivóvízforrásainak összehasonlító mikrobiológiai vizsgálata (*Comparative microbiological analysis of potable water resources of Győr (Hungary)*), *Hadmérnök*, XII:(1) (különszám) pp. 159–168 (2017)
- Krisztina Takács, Rajmund Kuti: Fenntartható vízellátás biztosításának aktuális kérdései (*Current questions for insurance of sustainable water supply*), *Védelem Tudomány, Katasztrófavédelmi Online Tudományos Folyóirat*, II:(2) pp. 304–317 (2017)
- Zoltán Grósz, Rajmund Kuti, Krisztina Takács: Biológiai fertőtlenítő anyagokkal szemben támasztott követelmények (*Requirements against biological disinfectant material*), *Hadmérnök*, XI:(2) pp. 62–69 (2016)

SCIENTIFIC BIOGRAPHY OF THE PHF CANDIDATE

Krisztina Takács was born on October 27, 1990 in Győr. She began her secondary school studies at the Gyula Krúdy High School in Győr, and after graduating from 2009 to 2015, she graduated from the Faculty of Agriculture and Food Science of the University of West Hungary in Mosonmagyaróvár, first with a degree in Food Engineering and then with Food Safety and Quality Engineering. In 2016, she started the full-time PhD program at the Doctoral School of Military Engineering, Faculty of Military Sciences and Military Training of the National Civil Service University. In addition to her university studies, she spent her internship in various food plants. Since September 2015 she has been working part-time at the Department of Agriculture of the Győr-Moson-Sopron County Government Office as a county food safety supervisor.

Professional career

In 2016, she performed co-consulting duties on dissertations written at the Faculty of Agricultural and Food Sciences of Széchenyi István University. In 2017 and 2018, in addition to active membership, she held the position of secretary and organizational reference of the Department of Technical Sciences of the National Association of Doctoral Students. During this period she was also an active member of the Department of Military Science of the National Association of Doctoral Students. Since June 2017 she has been an active member of the Hungarian Hydrological Society, and has participated in several programs organized by the Society. Since 2015 the István Széchenyi Faculty of Engineering has given several lectures on water safety in the framework of the Preventive Disaster Management subject.

She has a state-recognized "C" type state language exam in both German and English.

Scientific recognitions, awards

In 2012 at the Scientific Student Conference organized by the Faculty of Agriculture and Food Sciences of the University of West Hungary in the Plant and Food Science Section, the III. got a place. Then in 2013, the XXXI. In the 1st section of the National Scientific Student Circle Conference, 1st Agricultural Science Section, Food Technology, her work was awarded a special prize.

In 2014, she was awarded a Republic Scholarship by the Faculty of Agriculture and Food Sciences of the University of West Hungary for his excellent academic results.

Budapest, 25. August 2020

Krisztina Takács