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NITRATE AND NITRITE CONTENTS IN IN THE PRIVATE GROUND WATER WELLS

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ABSTRACT

The aim of the study was to investigation and statistical evaluation of nitrate and nitrite in ground sources of drinking water, particularly in private wells and springs in the surroundings of town Nitra, in the river basin Žitava. Samples were taken in the spring month May and the autumn month October of the same water sources. The contents of nitrate and nitrite was determined by test strips QUANTOFIX Nitrate and nitrite. The results were evaluated in the system SAS program, version 8.2. The difference of nitrate in drinking water sources between spring and autumn months was statistically evaluated by t-test. The nitrate content in drinking water samples taken from the surroundings of town Nitra, in the river basin Žitava, was measured in the spring month of May with exceeding values that exceeded the 50 $mg.L^{-1}$, which is the limit value for the adult human population, in the well of municipalities Veľká Maňa, Žitavce, Michal nad Žitavou, Malá Maňa, Uľany nad Žitavou, Hul, Kmeťovo and 50 $mg.L^{-1}$ was measured in spring Vlkas, in well of municipality Lúčnica nad Žitavou, Veľká Maňa, part of the Stará Hora. In the autumn month October measured nitrate content was reduced in samples taken in the municipalities Lúčnica nad Žitavou, Malá Maňa, Kmeťovo and Uľany nad Žitavou. The difference of nitrate content in water from water sources investigated in surroundings of town Nitra was not statistically significant *($p > 0.05$)* between the months May and October. The nitrite content in the same water sources in the surrounding of town Nitra was not detected.

Keywords: water; well; private; nitrate; nitrite

INTRODUCTION

The European Charter on Water, which was announced May 6, 1968 in Strasbourg, including the text, which is important for the understanding of water protection, and that there is no life without water and the water pollution is harmful to humans, so water resources need to be examined, checked and, if necessary, taken measures for their improvement.

The European Food Safety Authority – dietetic products, nutrition and allergies (NDA) **(EFSA, 2010)** elaborated on the request of the European Commission a scientific opinion on the reference water intake. Water is consumed from diverse sources, which include drinking water (from the faucet and bottled water), water in foods, drinks, water from the oxidation of nutrients in the human body. Water intake from foods and drinks can be defined as the total water intake, the sum of total water intake and water from the oxidation of nutrients is the overall disposition of water.

Characteristics of nitrates and nitrites

Nitrates and nitrites are naturally occurring ions that are part of the nitrogen cycle. The nitrate ion (NO_3^-) is a stable form. Chemically, non-reactive, but the state can be changed by microbial action. Nitrite ion (NO_2^-) containing nitrogen in a relatively unstable oxidation state. Chemical and biological processes may further change nitrite into various compounds or oxidize it into nitrate (ICAIR Life Systems, Inc., 1987).

Nitrate concentrations in natural waters based on different diffuse sources, such as the atmosphere, the wildlife and naturally derived from the degradation of soil organic matter in environment. The term nitrate was defined as the range of concentrations of NO_3^- only from natural sources. However, this term shall also include the organic matter in the soil from the rest of fertilized and non-fertilized crops, products of combustion and the evaporation of ammonia (NH_3) from synthetic and organic nitrogenous fertilizers and animal waste, other than naturally-derived NO_3^- **(Panno et al., 2006)**.

Some studies have defined values for nitrates, which is to determine the limit. If the nitrate concentration exceeds the limit, it can only be attributed to anthropogenic induced process **(Matschullat et al., 2000)**.

The occurrence of nitrates in drinking water and sources of drinking water pollution by nitrates

The occurrence of nitrate in drinking water is mainly associated with the use of inorganic fertilizers in agriculture. Nitrates are used as well as an oxidizing agent, potassium nitrate is used in the manufacture of glass, and sodium nitrite is used as a preservative in the production of smoked meat. Sometimes they can be added to foods and serve as a reservoir for nitrite. An excess nitrates easily passes into ground water **(Van Duijvenboden a Matthijsen, 1989)**.

Under aerobic conditions, the nitrates penetrate a relatively large amount into water resources in the soil, where there it does not grow the plant material. Nitrate can advance all the way to the lower layers of soil. Degradation or denitrification occurs only to a small extent in soil and rocks, where there is ground water. Under anaerobic conditions, nitrate may be degraded or almost completely denitrified to nitrogen. The presence of high or low mineral water, the amount of rain water, of other organic compounds, and physicochemical properties of the water are also important in the identification and evaluation of nitrates in soil **(Van Duijvenboden a Loch, 1983; Fewtrell, 2004; Dubrovský a Hamilton, 2010).**

The occurrence of nitrates in drinking water in Slovak republic

The average concentration of nitrate in the years from 1991 to 1995 in ground water of Slovakia accounted 36.17 ±71.25 mg.L^{-1} and a median 8.8 mg.L^{-1}. It is the result of a very specific distribution of the whole set of values, as nearly a third of the samples showed values lower than 3.0 mg.L^{-1}, and to almost 55% of the samples had nitrate concentrations below or equal to 11.3 mg.L^{-1}. These lower concentrations are implicitly linked to the mountain areas and in some cases (particularly in the case of the Danube River) to coast zone of surface water infiltration **(Rapant et al., 1996)**.

Reduced nitrate content according to the Water Research Institute in Bratislava in the years 2003 – 2011 was due to lower average application of nitrogen fertilizers and the reduction of agricultural lands. The results showed that the increase of nitrates in ground water in Slovakia slowed, not only due to the decline in agricultural production, but also as a result of implementation of the measures in accordance with **Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000** and other measures. It proves the assessment of the development trends in nitrate content compared with the previous period (2004 – 2007). The reduction in average concentrations of NO_3^- in ground water was found in 34% of evaluable subjects. The largest share recorded a stable development trend (45%) and an increasing trend of nitrate content was found in 21%. In many cases, however, it is lower than the concentration of 25 mg.L^{-1}. Effects of the implementation of the measures in housekeeping and in codes of good agricultural practice can be assumed that the extent of penetration of nitrogen into ground water should not substantial increase in the coming years **(Ondrejková, 2012)**.

Endangering human health caused by nitrates from water

The priority of all government policies around the globe there is sufficient quantity to healthy water. Around 18% of the world population lives in an environment with poor as far as highly problematic water quality. The market of water and aquatic environments, but differs significantly from other commodity prices on the supply side. The amount of water on our planet it remains constant and its availability in some areas is severely restricted. Less than 2% of the total amount of water that is about 1.4 billion cubic kilometers is exploitable population. On the other hand, demand for water increases. According to World Health Organization and agencies of Deutsche Bank Research, which regularly monitors the global market for water management, it increased water consumption in the last 50 years to double. Average water consumption, however, remains the same per capita, which means that water consumption has increased drastically for industry, agriculture and adjacent sectors. The requirements for the amount of water increases, but the quality of health safe water decreases, due to it's the pollution. As a new source of drinking water pollution and in general all the water we can include hormonally active substances called endocrine disruptors and pharmaceuticals. Existing technologies to remove these harmful substances is either ineffective or too costly and intrusive to the environment. Annual estimate of financial volume worldwide market for water is about 250 billion US dollars, of which almost 20% is investment in the development and implementation of new technologies in water treatment **(Černík a Zbořil, 2013)**.

The growing use of fertilizers, liquidation waste (mainly from livestock) and changes in land use are the main factors that lead to a gradual increase in the levels of nitrates in ground water over the past 20 years. In some areas of Denmark and the Netherlands, for example nitrate concentration increased about 0.2 to 1.3 mg.L^{-1} for one year **(WHO, 1985)**.

Individual outbreaks of the agricultural areas of the world, which contribute to problems of toxicity of the nitrate, are related to the well water; often contain more than 50 mg.L^{-1}. Nitrite levels in drinking water it is usually achieved below 0.1 mg.L^{-1} **(RIVM, 1993)**.

Factors influencing the occurrence of nitrates and nitrites in ground water

It is well known that ground water is a valuable natural resource which should be protected from deterioration and chemical pollution. However, the quality of ground water due to agricultural practices, population growth and economic development, the amount of nitrogen released into the subsurface from manure, waste and animal waste in the past decade has deteriorated. Because of the high solubility and mobility of nitrate through the water to the surface area of surface water their content increases, and they are a major threat to ground water and its contamination by nitrates **(Igúzquiza et al., 2015)**.

Many studies include characterization of the factors that influence spatial distribution of soil nitrogen at different scales, including climate, topography, soil type, type of land use and agricultural practices.

These factors are generally classified into two types:

- internal factors (such as basic materials, topography and soil types),
- external factors (including the type of land use and agricultural practices) **(Mendes a Ribeiro, 2010)**.

In accordance with **Lake et al. (2003)** are factors that affect the vulnerability of ground water nitrate pollution are:

1. leaching, quantity and quality (nitrate concentration) of water, leaving the root of the crops grown on the land;
2. soil characteristics can reduce nitrate pollution or lead to horizontal movement of water;
3. variations in low-permeability coating surface deposits, namely glacial origin, or alluvial muds and clays, which can form an impermeable cover layer and thereby preventing the movement of water;
4. distinguish between the aquifer e.g. geological units, which are highly permeable and/or cracked, and thus vulnerable to pollution and those smaller units which have low permeability and non-aquifer i. e. geological units that were not considered to be a risk of contamination by nitrates given their negligible permeability and the potential for limiting nitrate transport from diffuse sources.

An inverse relation between the depth and the concentration of nitrate is consistent with previous studies of ground water. Earlier transcended nitrogen is usually in deep ground water and can come from a period of intensive use of fertilizers. In this area, a better opportunity for the denitrification of nitrate, because ground water requires more time to change into greater depths. Moreover, if the deeper the well, the more likely that the sample contain ground water mixture of nitrates, which transgressed at different times **(Wheeler et al., 2015)**.

Topographic factors including altitude, inclination of the slope, the curvature of the vertical, horizontal curvature, the length of the slope, topography index of flow and moisture output, correlated significantly with soil properties and thus affect the penetration of the nitrate and nitrite in the ground water. The three most important variables are altitude, inclination, distance and length of the slope up to 1 km **(Zhang et al., 2012)**.

Research suggests that the use of land by controlled cultivation and fertilization is another crucial factor for change nitrogen in the soil. This fact is among other factors affecting the quality of ground water in agricultural areas **(Cesar a Roš, 2013)**.

In connection with the transfer of nitrates in ground water by **Wang et al. (2015)** the most important variable factors include depth of farmland, fertilizer and their variable group, duration of action, population density, aquifers and breeding of farm animals (with feeding).

Guideline values of nitrates and nitrites in drinking water

Guideline values by Government Regulation no. 354/2006 Coll. Slovak Republic, as amended by no. 496/2010 Coll. and 8/2016 Coll. (Nariadenie vlády č. 354/2006 Z. z. Slovenskej republiky, v znení č. 496/2010 Z. z. a 8/2016 Z. z.) are: limites for nitrate 50.0 mg.L^{-1} and nitrite 0.5 mg.L^{-1}. Sum of the ratios detected nitrate divided by 50 and detected quantities of nitrite divided by 3 must be less than or be equal to 1.0.

The nitrite content in drinking water at the outlet of the treatment plant must be less than 0.1 mg.L^{-1}. Guideline values of nitrate and nitrite by World Health Organization (2011): nitrate 50.0 mg.L^{-1} as nitrate ion (or 11.0 mg.L^{-1} as nitrate-nitrogen) to protect against methaemoglobinaemia in bottle-fed infants (short-term exposure), nitrite: 3.0 mg.L^{-1} as nitrite ion (or 0.9 mg.L^{-1} as nitrite-nitrogen) to protect against methaemoglobinaemia in bottle-fed infants (short-term exposure) and combined nitrate plus nitrite: the sum of the ratios of the concentrations as reported or detected in the sample of each to its guideline value should not exceed 1.0. This proof is made more difficult by the presence of microbial contamination and subsequent gastrointestinal infections, which can significantly increase the risk for this group of people. Inspection authorities should tighten control of water used for infants fed by this bottle for microbiological safety if the nitrate concentration is near the guideline value for nitrate. It is recommended that the water, having a content of nitrates of 100 mg.L^{-1} or more, not be used for infants fed from bottle. Inspection authorities for food safety, including water, they should critically assess the relation between methaemoglobinaemia and nitrate concentration in the range of 50 to 100 mg.L^{-1}. This recommendation is especially true where gastrointestinal infections occur at infants and children in the population. In this context, it is the best measure to prevent this condition and put more emphasis on prevention of microbiological risks. Recommendation nitrite content 3 mg.L^{-1} follow from the data obtained from studies in humans. Use the lowest level of nitrites 0.4 mg.kg^{-1} body weight means that a child who weighs 5 kg and consumes about 0.75 liters of drinking water, the indicative amount of nitrite is 3 mg.L^{-1}.

We have focused our study on the investigation of nitrate and nitrite in the ground water resources in the surroundings of Nitra, in the river basin Žitava. Following the main aim was determined following partial aims: sampling of the water from wells and springs in the surroundings of Nitra, in the river basin Žitava, analysis of water samples for nitrate and nitrite content and assessment of the results.

It was established a scientific hypothesis. It was established scientific hypotheses. My assume that the nitrate content in the water of a private well will be higher than the limit value of 50.0 mg.L^{-1} for adult human population in drinking water.

MATERIAL AND METHODOLOGY

The object of investigation was water from wells water resources in the nearby town of Nitra, in the basin Žitava.

Water sampling and water sampling procedure

We collected one water sample from 10 different sources in the surroundings of Nitra, in river basin Žitava, in the months of May 2015 (n = 10) and October 2015 (n = 10). Sampling places of the well water were these water resources: private well, municipality Veľká Maňa – sample no. 1; private well, municipality Lúčnica nad Žitavou – sample no. 2; private well, municipality Žitavce – sample no. 3; well, municipality Michal nad Žitavou –

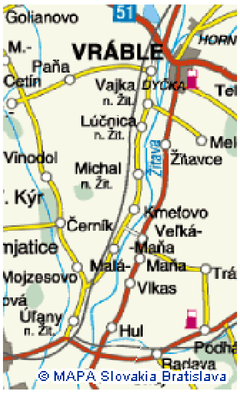

Figure 1 Water sampling sites.

sample no. 4; private well, municipality Malá Maňa – sample no. 5; well, municipality Uľany nad Žitavou – sample no. 6; private well, municipality Hul – sample no. 7; spring, municipality Vlkas – sample no. 8; private well, municipality Kmeťovo – sample no. 9; private well, municipality Veľká Maňa, part Stará Hora – sample no. 10. Capacity of the taken sample was of 250 mL in laboratory bottle with cap.

Analysis of water samples

Preparation of the water sample for analysis

Water analysis for the content of nitrate and nitrite was carried out directly in the field as described below in this chapter.

Analysis of water samples for nitrate and nitrite content

Measurement of nitrates and nitrites

Test strips QUANTOFIX Nitrato a Nitrito from company Macherey-Nagel, Nemecko were used to measure the, type 10 – 500 mg.L^{-1} NO_3^-, 1 – 80 mg.L^{-1} NO_2^-.

QUANTOFIX test strip consists of a plastic strip 0.2 mm thick, on which is affixed at the lower end of test strips specific for the measurement of nitrate and nitrite. The size of the display surface papers allows easy comparison with the color scale on the aluminum tube, which is wrapped papers. To preserve the effectiveness and reliability of the strips to measure the protective cap tubes filled with drying agent. Strip length is sufficient for the testing of water samples. The advantage of the test strip for the detection of nitrate and nitrite in water samples is that it is quick and relatively reliable method.

Measurement procedure

Measurement of nitrate and nitrite contents was carried out by following the steps recommended by the manufacturer of the test strips Macherey-Nagel, Germany:

a) we take hold of test strips between thumb and forefinger so that the adhered specific test slip was to the bottom end,

b) we plunge a test strips into water in a beaker for 1 second,

c) we taken a test strips from the water sample and hold between thumb and forefinger for 60 seconds,

d) we attach a test strips to color scale indicating the numerical values of nitrate and nitrite content on the packaging of test papers and determine the content of nitrates and nitrates in measured water sample in mg.L^{-1}.

Statistical methods

The obtained data were assessed according to basic statistical characteristics ($\overline{x}$ = mean, *SD* = standard deviation and c_v = coefficient of variation). T-test at the significance level of α = 0.05 was used to compare a difference of nitrate content between taken samples in mounth May and mounth October. It was used program system SAS, version 8.2.

RESULTS

Nitrate and nitrite contents in water resources of private wells in the surrounding area of Nitra

We present in this chapter the results of verification of the contents of nitrates and nitrites that we measured in the samples of water from wells and springs. In the Figures we present the results of nitrate content in water samples taken in May and October 2015 by individual water sources that are documented in the Figure with that brief description.

Water source of water samples no. 1 shows Figure 4

Water source of water samples no. 1 is located in the center of municipality Veľká Maňa. In its surroundings is leafy park with a manor-house and also dump. Water source is located in residential part of the municipality. Nitrate content in water sample of taken sample no. 1 from home well in the municipality of Veľká Maňa was in May 150.0 mg.L^{-1} and in October also 150.0 mg.L^{-1}. In a water sample from the same source was measured no nitrite content.

Figure 2 Cup containing water sample, water in a beaker for the determination of nitrate and nitrite test strips QUANTOFIX Nitrato and Nitrito from company Macherey-Nagel **(Foto: Angelovičová, 2016)**.

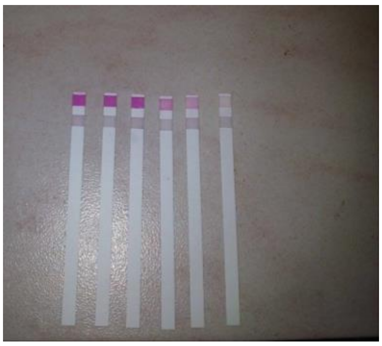

Figure 3 Test strips QUANTOFIX semi-quantitative determination of nitrate and nitrite in water samples **(Foto: Szabóová, 2016)**.

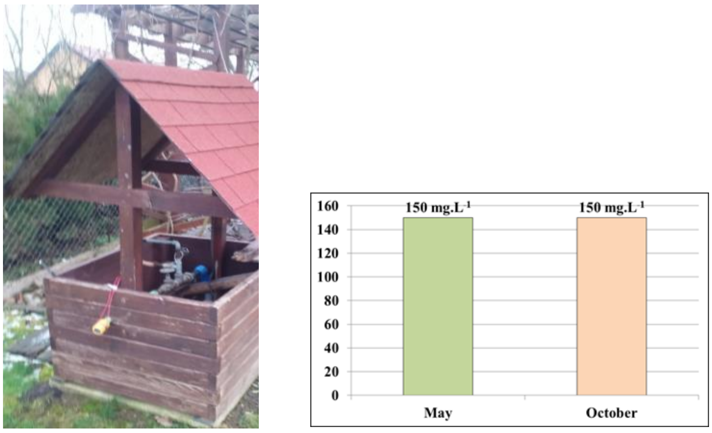

Figure 4 Water source of water sample no. 1 and nitrate content in month may and october **(Foto: Szabóová, 2015)**.

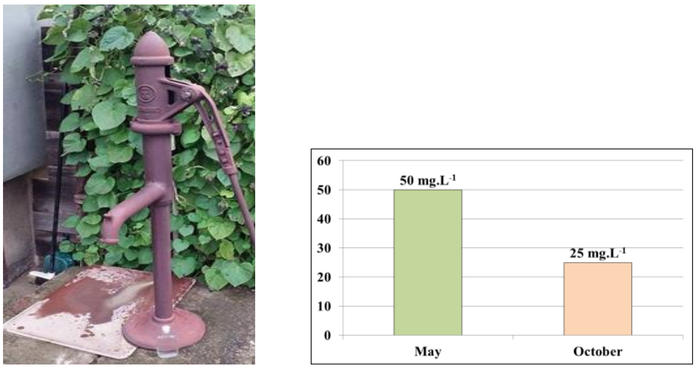

Figure 5 Water source of water sample no. 2 and nitrate content in month may and october **(Foto: Szabóová, 2015)**.

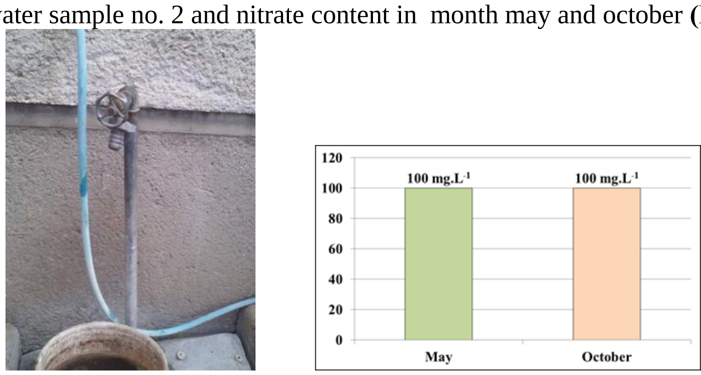

Figure 6 Water source of water sample no. 3 and nitrate content in month may and october **(Foto: Szabóová, 2015)**.

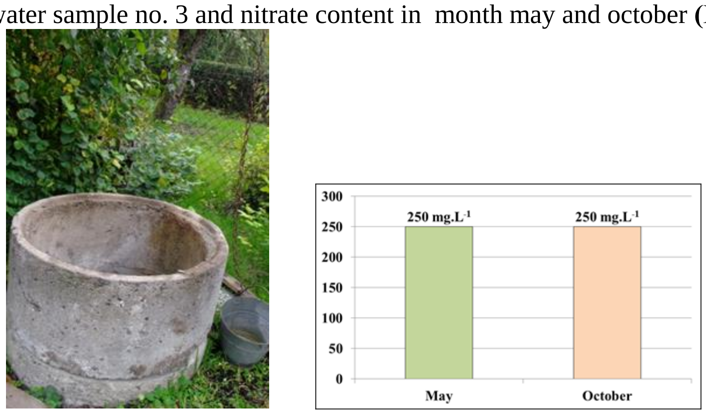

Figure 7 Water source of water sample no. 4 and nitrate content in month may and october **(Foto: Szabóová, 2015)**.

Water source of water samples no. 2 shows Figure 5

Water source of the water sample no. 2 is located on the outskirts of municipality Lúčnica nad Žitavou. In its nearness there is a cemetery and railway. This water source is located in a sparsely populated part of the municipality. Nitrate content in water from home well in the municipality Lúčnica nad Žitavou was 50.0 $mg.L^{-1}$ in May and 25.0 $mg.L^{-1}$ in October. In a sample of water from the same source was measured no nitrite content.

Water source of water samples no. 3 shows Figure 6

Water source sample no. 3 is located in the municipality Žitavce. In the nearness of private water resource there is a community center, shopping center, and old vacant apartments. In the gardens, which are located near the

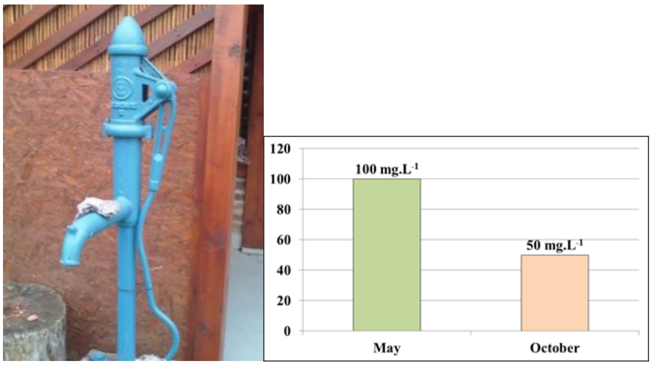

Figure 8 Water source of water sample no. 5 and nitrate content in month may and october **(Foto: Szabóová, 2015)**.

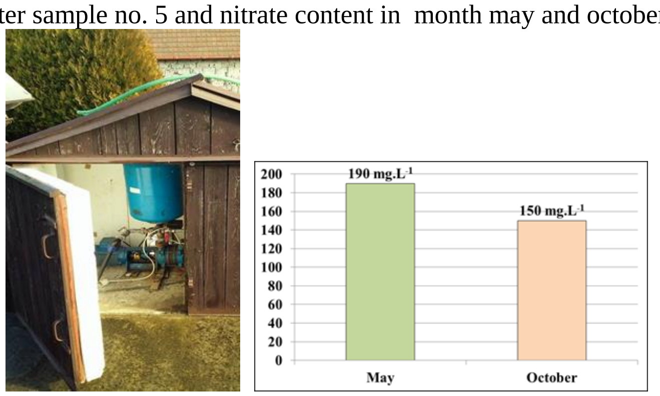

Figure 9 Water source of water sample no. 6 and nitrate content in month may and october **(Foto: Szabóová, 2015)**.

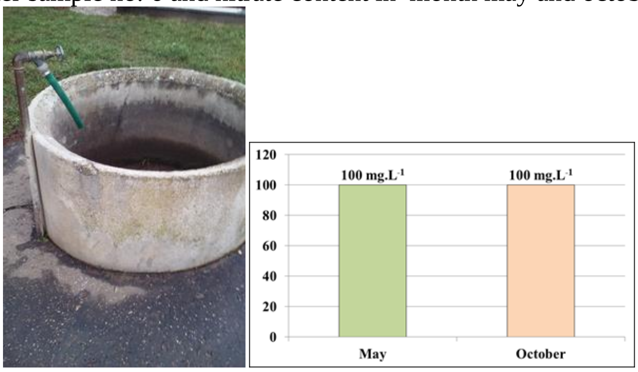

Figure 10 Water source of water sample no. 7 and nitrate content in month may and october **(Foto: Szabóová, 2015).**

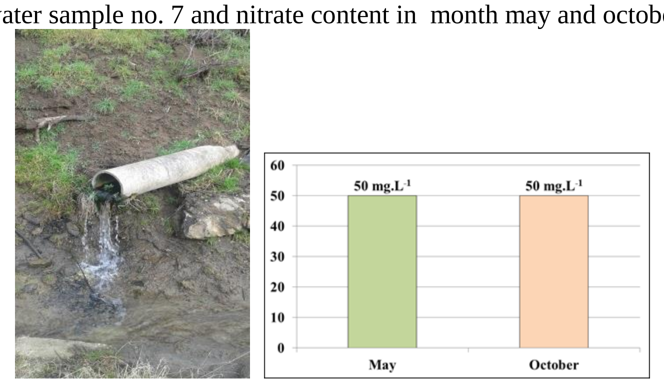

Figure 11 Water source of water sample no. 8 and nitrate content in month may and october **(Foto: Szabóová, 2015)**.

water source, there were not grown any crops. Nitrate content in water from private well in the municipality Žitavce was 100.0 mg.L^{-1} in May and also 100.0 mg.L^{-1} in October. In a sample of water from the same source was measured no nitrite content.

Water source of water samples no. 4 shows Figure 7

Water source sample no. 4 is located on the outskirts of the municipality Michal nad Žitavou. In the nearness there is a garden, where every year grows crops. The well is open and the ground water rain water is mixed there. Water source is located on the outskirts of the municipality adjacent to agricultural use of arable land. Nitrate content in water from private well in the municipality Michal nad Žitavou was 250.0 mg.L^{-1} in May and also 250 mg.L^{-1} in October. In a sample of water from the same source was measured no nitrite content.

Water source of water samples no. 5 shows Figure 8

Water source sample no. 5 is located on the outskirts of the municipality Malá Maňa. In its nearness are fields where crops cultivate every year such as cabbage,

Figure 12 Water source of water sample no. 9 and nitrate content in month may and october **(Foto: Szabóová, 2015).**

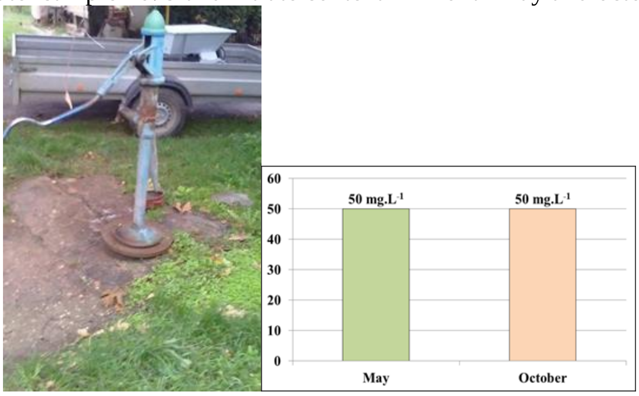

Figure 13 Water source of water sample no. 10 and nitrate content in month may and october **(Foto: Szabóová, 2015)**.

potatoes, cauliflower. Nitrate content in water from private well in the municipality Malá Maňa was in May 100.0 mg.L^{-1} in May and 50.0 mg.L^{-1} in October. In a sample of water from the same source was measured no nitrite contet.

Water source of water samples no. 6 shows Figure 9

Water source sample no. 6 is located on the outskirts of the municipality Kmeťovo. In its nearness are used gardens, agriculturally cultivated fields and small collective farm, where are bred dairy cows. Nitrate content in water from private well in the municipality Kmeťovo was 190.0 mg.L^{-1} in May in October and 150.0 mg.L^{-1} in October. In a sample of water from the same source was measured no nitrite content.

Water source of water samples no. 7 shows Figure 10

Water source sample no. 7 is located on the outskirts of the municipality Hul. In its nearness are around gardens and fields where potatoes are grown every year of early and late sorties. Nitrate content in water from private well in the municipality Hul was 100.0 mg.L^{-1} in May and 100.0 mg.L^{-1} in October. In a sample of water from the same source was measured no nitrite content.

Water source of water samples no. 8 shows Figure 11

Water source sample no. 8 was spring, which is located approximately one kilometer from municipality Vlkas. In its surroundings, there are fields in which the yearly crops cultivate mainly as corn, wheat, barley. The water is obtained from ground springs. Nitrate content in water from private well in the municipality Vlkas was 50.0 mg.L^{-1} in May and 50.0 mg.L^{-1} in October too. In a sample of water from the same source was measured no nitrite content.

Water source of water samples no. 9 shows Figure 12

Water source sample no. 9 is located on the outskirts of municipality Úľany nad Žitavou. Nearby, there are gardens, where vegetables are cultivated and fields are agriculturally used. The surrounding gardens are characterized by the cultivation of fruit trees. Nitrate content in water from private well in the municipality of Uľany nad Žitavou was 150.0 mg.L^{-1} in May and 100.0 mg.L^{-1} in October. In a sample of water from the same source was measured no nitrite content.

Water source of water samples no. 10 showns Figure 13

Water source sample no. 10 is located on the outskirts of municipality Veľká Maňa, part of the Stará Hora. The sampling place is the wine region, located on a mild slope above the municipality Veľká Maňa. Nitrate content in water from private well near the municipality Veľká Maňa, part of the Stará Hora was 50.0 mg.L^{-1} in May and 50.0 mg.L^{-1} in October too. In a sample of water from the same source was measured no nitrite content.

The average content of nitrate and nitrite in water resources of surroundings Nitra according to the time sampling of water

Comparison of nitrate content in water resources of surroundings of Nitra according to the time water sampling of water is given in table 1.

The average content of nitrates in water resources observed in the surroundings Nitra was 119.00 mg.L^{-1} in May, while the minimum was 50.00 mg.L^{-1} and the maximum value of 250.00 mg.L^{-1}. Nitrate content in water

Table 1 Average nitrate content in water of water sources of surroundings Nitra.

Taken samples	n	x̄	Min	Max	SD	c_v, %	t-test
May	10	119.00	50.00	250.00	66.24	55.66	0.55^{-}
October	10	102.50	25.00	250.00	67.13	65.50	

Note: n – number of samples, x̄ – aritmetical mean, Min – minimum, Max – maximum. s – standard deviation, v_k – coefficient of variation. Statistically non-significant difference (p >0.05).

resources was reduced to average value 102.50 mg.L^{-1} in monitored surroundings Nitra in October compared to the month of May, with the variation range from 25.00 to 250.00 mg.L^{-1}. According to the results of standard deviation and coefficient of variation, we found that greater variation of measured nitrate levels in water resources of surroundings Nitra was in October (SD = 67.13 mg.L^{-1}, c_v = 65.50%) compared to the nitrate content of water resources in surroundings Nitra in the month of May (s = 66.24 mg.L^{-1}, c_v = 55.66%). The difference in nitrate levels in water resources of monitored surroundings Nitra between the months of May and October was not statistically significant (p >0.05). The nitrite content in water of the same water sources surrounding area of Nitra was not found.

DISCUSSION

Based on the results of ground water pollution and exceeding the limits of nitrate and nitrite in the ground water world organizations have adopted certain measures. Directive 2000/60/EC of the European parliament and of the Council establishes a framework for community action in the field of water policy requires member states to characterize the quality of its ground water, identify trends and to introduce measures to achieve good quantitative state to 15 years from the date of entry into force of this directive.

According to literary knowledge are nitrates and mainly nitrites harmful for human from health aspect. Nitrates and nitrites are found in the atmosphere, soil, water, and foods. In our work we have focused mainly verify the nitrate and nitrite contents that are present in ground water. As we mentioned above, ground water is on the first place of obtaining quality drinking water. That is the reason, why we should be protecting its quality, protects drinking water. In recent decades, it is an alarming increase in nitrate and nitrite contents before good quality ground water. We can mention that nitrate concentrations to 1500 mg.L^{-1} were detected in ground water, example in the agricultural area of India **(Jacks and Sharma, 1983)**. Ground water in coastal areas Daweijia territory in north-east China is characterized with high nitrate concentration variation in values from 33 to 521 mg.L^{-1} **(Dongmei et al., 2015)**. Serious problems with the accumulation of nitrite have been rare so far mainly in the Nordic countries, such as Finland. However, also in Finland samples of water were found, which has been the accumulation of nitrite almost critical guideline value (0.50 mg.L^{-1}) **(Lipponen et al., 2002)**. Over the limit nitrate levels above 100 mg.L^{-1} were measured also in Belgium, in areas with intensive agriculture **(Batlle and Aquilar et al., 2007)**. Amount of nitrate and nitrite monitors in Slovakia, and regularly samples collect of water pipes, as well as samples of other resources such as are ground water springs, rivers, rain water and other. According to the results of the Water Research Institute in Bratislava has a content of ground water nitrites and nitrates in the Slovak Republic is still decreasing. The average values are also the limit level. However, these results misrepresent the high-mountain areas and areas with low agricultural activity. The results achieved in our work, in which water samples were collected from water sources serving households are located in the nearby town of Nitra, in the river basin Žitava, where it is still actively farming and nitrate levels are well above the limit. On the other hand, it is favorable that the nitrates were not presented in the ground water. Over limit of nitrate content above 50 mg.L^{-1} was in all samples, except for sample no. 2, where even in October decreased nitrate content to 25 mg.L^{-1}, samples no. 8 and 10. In the sample no. 5 was in October satisfactory nitrate content, but in the month of May was the nitrate content of 100 mg.L^{-1}. Especially surroundings of the source of well water had an effect on the occurrence of nitrate in larger quantities.

Sample no. 1 was located near a park where they grow broadleaved trees. They cannot have an impact on the content of nitrates. There is also, however, a waste dump, which could cause over limit values. According to **Wheeler et al. (2015)** in forests keep nitrates in soil and water longer than in other areas, because trees are not degraded to such an amount of nitrogen than other plants.

Water source of sample no. 2 was located in a sparsely populated area of the village, near the cemetery is located. In the nearness of the source is not carried out intensive agricultural activity. Sample no. 2 had as the only one satisfactory content of nitrate, less than 50 mg.L^{-1}. In October, the nitrate content decreased to 25 mg.L^{-1}. If we were investigated also the other water quality parameters and water would met these criteria, it could be water from the wells used for drinking.

Sample no. 3 was collected from a quiet environment. There is nothing not grow for several years. Even though, the occurrence of nitrate was in above the threshold rate. In all probability it could have been caused in this case, the proximity of permeable septic tanks, which appeared from the well in less than four meters. In the past it is not introduced such strict measures to prevent penetration of their contents. According to STN 75 5115 should be household wells for at least 12 meters from the permeable septic tank, piping internal drains and sewer connections.

Sample no. 4 was collected from open wells, where water was stirred rainwater and ground water. This water sample measured significantly exceeded the permissible limit of nitrate. According **Outram et al. (2016)**, who investigated the influence of precipitation on the transfer of phosphates and nitrates into the ground water. Precipitation has a big impact on nitrate content in ground water or rainwater.

Therefore, we should not be surprised that in a sample no. 4 was measured nitrate content up to 250 mg.L^{-1}.

In the sample no. 5 was observed decrease of nitrates in October. We assume that this decrease was caused just grown crops. On the fields were cultivated especially early potatoes, cauliflower and cabbage in recent years. These plants need for their growth sufficient amount of nitrogen that comes through nitrogen fertilizers. Crop depletes nitrogen in the soil and it is further not get into ground water.

Sample no. 7 was collected from the water source; where for surrounding area is also typical growing potatoes. In this sample, however, there was not a decrease of nitrates in repeated measurements in October.

Sample no. 6 was collected from the land, which is located near the small agricultural cooperatives, where there is farm of breeding dairy cows. This is probably the major factor that influenced the nitrate content in water up to 190 mg.L^{-1}. Permitted limit has been exceeded almost 4-fold. We assume that it may cause the presence of urea in the near ground water resources.

Sample no. 8 was collected from ground water springs in the vicinity of the village Vlkas. This water sample contained a nitrate threshold level 50 mg.L^{-1}. Water source is surrounded by fields where crops are grown for animal feed. We provided that these crops to a greater extent from soil collected nitrogen, and soil is not fertilized the same extent as in the surrounding villages, from which we not collected water samples from water sources.

Water source of sample no. 9 is located in the garden of a family house. Surroundings accounted other gardens. In these gardens is a long tradition of growing vegetables and fruit trees. We collected water samples in the month of May and October, while in October decreased nitrate content from 150 mg.L^{-1} to 100 mg.L^{-1}. Decrease of nitrates may result from the use of nitrogen cultivated plants for their growth.

High levels of nitrates in ground water, as stated in professional literature review, could be due to the particular use of nitrogen fertilizers. According to the results disclosed by **Wheeler et al. (2015),** nitrate concentration decreases with increasing depth. Well from which water was collected, was characterized by depth of only 3 m, which may therefore be another cause of high nitrate level in the water.

Sample no. 10 was collected from wine-growing region. This area is located on a gentle slope. According to the research work **Zhang et al. (2012)** vineyards have an impact on the content of nitrates and nitrites in the soil and thus in ground water, as well as the length of the vineyard acreage and depth of their root system. Length of hillside vineyards exceeded in research of these authors one kilometer. The results of the research confirmed that the length of the slope one km vineyard was the limit for nitrate content. With increasing depth and slope length decreased content of nitrates and nitrites.

Samples that we examined were collected from a rural area. In general we can state that over the limit for nitrates in water of the investigated water resources were mainly due to the fact that in this area is intensively fertilized soil. Another factor affecting the increased nitrate content is certainly the fact that in various municipalities where the samples were collected, there is no sewerage.

Thus each house has a cesspool which in most cases is leaking because in the past did not put such emphasis on their isolation as today. It happens that the content of the cesspool in some cases released into the garden. Ultimately, for soil and ground water and water resources (from which is used for drinking water), in some cases residents themselves are responsible in their activities.

As stated by **Lukačínová et al. (2012)** in the publication that the results extend knowledge about the health risks of lifetime exposure to low doses of cadmium in drinking water rats, we are also of the same opinion, but in connection with exceeding values of nitrate in water. We agree with their conclusions, the results must be evaluated for more intervals of time, not only on the basis of the start and end of the experiment, and in this case the spring and autumn.

CONCLUSION

In surroundings of the town Nitra was measured different content of nitrates and nitrites in water samples from private wells or springs depending on the location and sampling in the months of May and October, 2015. Based on analysis of samples of well water from various water sources in the surroundings of Nitra, in the river basin Žitava can be stated as follows:

a) The measured nitrate content in ground water exceeded the 50 mg.L^{-1}, which is the limit value for the adult human population and for children dependent on the bottle 15 mg.L^{-1}, in the well Veľká Maňa, Žitavce, Michal nad Žitavou, Malá Maňa, Uľany nad Žitavou, Hul, Kmeťovo and 50 mg.L^{-1} were measured in spring Vlkas, in the well Lúčnica nad Žitavou, Veľká Maňa, part of the Stará Hora.

b) Any content of nitrite not detected in the taken samples of the water resources in the surrounding area of Nitra, in the river basin Žitava.

In our work, we also examined 10 water samples for nitrate and nitrite contents, depending from term of agro-technical time, in month May and October, and can be stated as follows:

- Measured nitrate content was reduced in October compared to the nitrate levels in the month of May in water samples taken in the municipalities Lúčnica nad Žitavou, Malá Maňa, Kmeťovo, Uľany nad Žitavou.
- The nitrate content of the other samples has not been changed from time aspect, which does not decreased nor increased in October compared to the nitrate levels in May.
- The difference in nitrate level in water of investigated water resources of surrounding area of Nitra, in the river basin Žitava, was not statistically significant different (p >0.05) between samples taken in May and October.

Based on the results observed at solving our work, we recommend continued monitoring of the nitrate content in water resources at regular time cycles, and the results stored in the databases.

Various factors have a significant impact on the nitrate content present in ground waters, which are presented in theoretical part of work and confronted with our results.

We recommend monitoring, and evaluating the factors that influence to increase nitrate levels in ground waters for further research of nitrates in the water.

Because in water samples dominated overflow occurrence of nitrates in ground water, it is important to recommend the results to their use in practical terms, through communication with the owner of the private water resource and management of farms and growers of crops and advised the procedure for the gradual reduction of nitrates in the soil under the checking nutrient reserves. It is one of the possibilities to reduce the nitrate in ground water.

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