



## **Physicochemical Research of Mineral and Mountain Spring Waters in Bulgaria**

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### **Author's contribution**

*The sole author designed, analysed, interpreted and prepared the manuscript.*

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### **ABSTRACT**

In Bulgaria is observed a great variety of spring waters. They are mineral and mountain spring waters. According to their temperature they can be cold (up to 37° C), warm (from 37° C to 60° C) and hot (over 60° C). This is Bulgarian standard, European Union.

The mountain spring waters are cold with temperature up to 25° C.

In Bulgaria for drinking mineral and mountain spring waters are valid Ordinance No 9 / 2001, Official State Gazette, issue 30, and decree No. 178 / 23.07.2004.

By their chemical composition they fall into three categories – low mineralized (up to 2 g/L), moderately mineralized (2 to 15 g/L) and highly mineralized (15 – 30 g/L). According to their chemical composition the mineral waters are divided into sulphate, sulfide, hydrogen carbonate, chloride and carbonic. With regards to their gas composition they are nitrogen, sea and carbonic waters.

The objective of the current study is to show springs examined by physicochemical parameters and correspond to Ordinance No 9 / 2001, Official State Gazette, issue 30, and decree No 178 / 23.07.2004 about the quality of water intended for drinking and household purposes.

In the current study mineral waters and mountain spring waters from mountain regions of Bulgaria have been studied. It is well known that in the mountain areas of Bulgaria live the most of long-living people and centenarians. The studies are conducted by microbiological laboratory of Trakia University, Stara Zagora headed by Nedyalka Valcheva, accredited laboratory Eurotest Control, and the laboratory of Scientific Research Center of Medical Biophysics.

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## 1. INTRODUCTION

In the current study are shown mineral waters and mountain spring waters from mountain regions of Bulgaria. It is well known that in the mountain areas of Bulgaria live the most of long-living people and centenarians.

Studies are carried out for mineral waters in the regions of Sofia, Plovdiv, Haskovo, Stara Zagora, Pazardhik, Varna, Burgas, Blagoevgrad, Yambol, Pleven and Lovech.

Research of mountain spring waters is conducted in the municipalities of Smolyan and Teteven, area well known for its people living people and centenarians. The mountain spring water is one of the factors for health and increased longevity. Shown is up-to-date data from 2020 about mountain spring water Teteven.

Water is the main substance of life. The human body is composed from 48 to 54% of water for adult people. With aging, the percentage of water in the human body decreases. Hence, the factor of water quality is the essential factor for the research (Pocock et al., 1981; Howard, Hopps, 1986). Water is present in the composition of the physiological fluids in the body and plays an important role as an inner environment in which the vital biochemical processes involving enzymes and nutrients take place. Water is the main factor for metabolic processes and aging (Ignatov, Mosin, 2012, 2013). Earlier studies conducted by us have demonstrated the role of water, its structure, isotopic composition and physicochemical (pH, temperature) in the growth and proliferation of prokaryotes and eukaryotes in water with different isotopic content (Mosin, Ignatov, 2012, Mosin, 2013).

## 2. MATHERIALS AND METHODS

We analyze springs examined in respect of physicochemical composition, and comply with Ordinance No 9 / 2001, Official State Gazette, issue 30, and decree No 178 / 23.07.2004 about the quality of water intended for drinking and household purposes.

## 2.1 Methods for Physicochemical Analysis

Method for determination of color according to Rublyovska Scale – method by Bulgarian State Standard (BDS) 8451 : 1977;

Method for determination of smell at 20°C — method BDS 8451 : 1977 technical device – glass mercury thermometer, conditions No 21;

Method for determination of turbidity - EN ISO 7027, technical device turbidimeter type TURB 355 IR ID No 200807088;

Method for determination of pH – BDS 3424 : 1981, technical device pH meter type UB10 ID NoUB10128148;

Method for determination of oxidisability – BDS 3413 : 1981;

Method for determination of chlorides – BDS 3414 : 1980;

Method for determination of nitrates – Validated Laboratory Method (VLM) – NO<sub>3</sub> – No 2, technical device photometer "NOVA 60 A" ID No 08450505;

Method for determination of nitrites – VLM NO<sub>2</sub> – No 3, technical device photometer "NOVA 60 A" ID No 08450505;

Method for determination of ammonium ions – VLM – NH<sub>4</sub> – No 1, technical device photometer "NOVA 60 A" ID No 08450505;

Method for determination of general hardness – BDS ISO 6058;

Method for determination of sulphates – VLM - SO<sub>4</sub> – No 4, technical device photometer "NOVA 60 A" ID No 08450505;

Method for determination of calcium – BDS ISO 6058;

Method for determination of magnesium – BDS 7211 : 1982;

Method for determination of phosphates – VLM - PO<sub>4</sub>– No 5, technical device photometer "NOVA 60 A" ID No 08450505;

Method for determination of manganese – VLM – Mn – No 7, technical device photometer "NOVA 60 A" ID № 08450505;

Method for determination of iron – VLM – Fe – No 6, technical device photometer "NOVA 60 A" ID No 08450505;

Method for determination of fluorides – VLM – F – No 8, technical device photometer "NOVA 60 A" ID No 08450505;

Method for determination of electrical conductivity – BDS EN 27888, technical device – conductivity meter inoLab cond 720 ID No 11081137.

### 3. RESULTS AND DISCUSSION

Physicochemical research is conducted of mineral and mountain springs in Northern and Southern Bulgaria.

In Southern Bulgaria are examined springs in the regions of Plovdiv [1], Haskovo [2,3,4], Stara Zagora [5,6], Sliven [7], Burgas [8], Yambol, Pazardzhik, Yambol, Blagoevgrad [9].

Performed are specific physicochemical microbiological studies of springs from Southern Bulgaria [10,11,12].

In Northern Bulgaria are examined mineral springs in the regions of Varna [13,14], Lovech [15], Sofia Pleven. In Northern Bulgaria there is a great variety of mountain spring waters. The highest number of springs tested is in municipalities of Teteven [16,17], Yablanitsa [18] and Ugarchin [19], Lovech region and Smolyan region [20]. Table 1 shows bacteria during studies and microbiological parameters [21]. Table 2 shows the springs by regions, which correspond to Ordinance No. 9 / 2001, Official State Gazette, issue 30, and decree No. 178 / 23.07.2004 [22]. Table 3 is with physicochemical composition for mountain source Dolnata cheshma, Teteven, Bulgaria.

**Table 1. Bacteria during study and microbiological parameters**

Type of bacteria	Norm	Limit value
<i>Escherichia coli</i>	100	cfu/cm <sup>3</sup>
Coliforms	100	cfu/cm <sup>3</sup>
<i>Clostridium perfringens</i>	100	cfu/cm <sup>3</sup>
<i>Pseudomonas aeruginosa</i>	250	cfu/cm <sup>3</sup>

**Table 2. Springs by regions, which correspond to Ordinance No. 9 / 2001, Official State Gazette, issue 30, and decree No. 178 / 23.07.2004**

Region	Spring
Sliven	Sliven Mineral baths; Hadji Dimitar, Shivachevo; Banya; Gunchov Spring, Karandila locality, Sliven; Nova Zagora
Varna	Drilling No P83-St.St. Konstantin and Elena; P-1x-Aquarium; P-106 x Dom Mladost; P-161xPrimorski;
Burgas	Burgas Mineral Baths; Shivarovo; Polyanovo; Drilling No B73-Medovo; Drilling No B73-Kamenar;
Yambol	Karavelovo; Stefan Karadzhovo;
Haskovo	Drilling No. 2VP, Drilling No. 3VP, KEI No. 5
Stara Zagora	Drilling No. K-3, Ovoshnik, Drilling No. SZ-37, Yagoda; Trakia, St. Nikolay, Holly Mother of God; Center Maglij; Kazanlak; Kran-Enina; Ayazmo; Trite Chuchura; Pavel Banya - Drilling No. SZ-7; Drilling No. SZ-8; Drilling No. X-19; Drilling No. 3;
Plovdiv	Drilling No. 16-Lenovo; Drilling No. 1-Asenovgrad; Badjova voda. Hisar – Key Momina Banya; Kei Momina Salza; KEI Stublata; KEI Toplitsata; Svejest; Bistritsa; Bancheto Miromir; Choban Chesma; Chair Banya; Drilling No. 1; Staro Zhelezare Drilling No. 2; Staro Zhelezare Drilling No. 4; Drilling No. 3; Drilling No. 5; Drilling No. 6; Drilling No. 7; Parilkite; Bulgarian Rose; Narechenski bani – KEI Banski Kaptaj; Soleno izvorche. Banya – KEI Tsentralen Kaptaj; Jensko Banche; Drilling No. 1 – Kokalche; Drilling No. 8 – Dragoyново; Drilling No. 8
Pazardzhik	No. 2 -Vetren dol; Strelcha Velingrad – Drilling No. 5 Syarna banya; Drilling No. 3 Mizinka; Drilling No. 7 – Veliova banya; Varvara - Drilling No. 3 - Varvara; Drilling No. 5 - Varvara; Drilling No. 6 – Varvara. Banya – KEI No. 1 - Bancheto; KEI No. 2-Vetren dol; KEI No. 1 - Bancheto;
Blagoevgrad	Rupite
Sofia	Drilling No. 1- Ivanyane; Drilling No. 3-Gorna Banya; KEI Pchelinski bani; Sofia - Center
Pleven	Dolni Dabnik - Gradina
Lovech	Teteven - Dolnata cheshma; Gornata cheshma; Sondata; Klindiovo; Babintsi; Gechovoto. Golyam izvor – Tulyushovets; Krivina Troyan – Shipkovo; Chiflik. Letnitsa – Krushuna

**Table 3. Physicochemical parameters of mountain spring water Dolnata cheshma, Teteven**

Controlled parameter	Measuring unit	Maximum limit value	Result
1. pH	pH values	$\geq 6,5$ и $\leq 9,5$	7.9±0.1
2. Electrical conductivity	$\mu\text{S}/\text{dm}^3$	2000	482 ±15
3. Total hardness	$\text{mg}\text{ekv}/\text{dm}^3$	12	5.72 ±0.57
4. Color	Chromaticity Values	Acceptable	8±1
5. Turbidity	FNU	Acceptable	<1.0
6. Permanent Oxidation	$\text{mgO}_2/\text{dm}^3$	5.0	0.31±0.3
7. Odor	force	Acceptable	Acceptable
8. Potassium (K)	$\text{mg}/\text{dm}^3$	-	1.5±0.2
9. Sodium (Na)	$\text{mg}/\text{dm}^3$	200	2.5±0.3
10. Calcium (Ca)	$\text{mg}/\text{dm}^3$	150	94.4 ±9.4
11. Magnesium (Mg)	$\text{mg}/\text{dm}^3$	80	12.1 ±1.21
12. Zinc (Zn)	$\text{mg}/\text{dm}^3$	4.0	0.0167±0.0017
13. Iron (Fe)	$\mu\text{g}/\text{dm}^3$	200	9.0±0.9
14. Manganese (Mn)	$\mu\text{g}/\text{dm}^3$	50	1.6±0.2
15. Ammonium ion ( $\text{NH}_4^+$ )	$\text{mg}/\text{dm}^3$	0.50	0.013±0.001
16. Hydrocarbonates ( $\text{HCO}_3^-$ )	$\text{mg}/\text{dm}^3$	-	184 ±9
17. Carbonates ( $\text{CO}_3^{2-}$ )	$\text{mg}/\text{dm}^3$	-	<2.0
18. Sulphates ( $\text{SO}_4^{2-}$ )	$\text{mg}/\text{dm}^3$	250	109.8±11.0
19. Phosphates ( $\text{PO}_4$ )	$\text{mg}/\text{dm}^3$	0.5	<0.1
20. Chlorides ( $\text{Cl}^-$ )	$\text{mg}/\text{dm}^3$	250	1.2±0.1
21. Fluorides ( $\text{F}^-$ )	$\text{mg}/\text{dm}^3$	1.5	0.11±0.01
22. Nitrates ( $\text{NO}_3^-$ )	$\text{mg}/\text{dm}^3$	50	3.9 ±0.4
23. Nitrites ( $\text{NO}_2^-$ )	$\text{mg}/\text{dm}^3$	0.5	<0.05
24. Mercury (Hg)	$\mu\text{g}/\text{dm}^3$	1.0	<1.0
25. Cadmium (Cd)	$\mu\text{g}/\text{dm}^3$	10	<1.0
26. Copper (Cu)	$\text{mg}/\text{dm}^3$	2.0	0.0043±0.0004
27. Nickel (Ni)	$\mu\text{g}/\text{dm}^3$	20	<2.0
28. Lead (Pb)	$\mu\text{g}/\text{dm}^3$	10	<10
29. Aluminum (Al)	$\mu\text{g}/\text{dm}^3$	200	8.8±0.9
30. Antimony (Sb)	$\mu\text{g}/\text{dm}^3$	5.0	<5.0
31. Arsenic (As)	$\mu\text{g}/\text{dm}^3$	10	<10
32. Boron (B)	$\text{mg}/\text{dm}^3$	1.0	0.0206±0.0021
33. Selenium (Se)	$\mu\text{g}/\text{dm}^3$	10	<10
34. Chromium (Cr)	$\mu\text{g}/\text{dm}^3$	50	1.8±0.2

The properties of mountain spring water are owed to its purity from snow and ice melting [23]. One of its unique features is the availability of additional energy among the hydrogen bonds in their transition from a solid to a liquid phase [24]. Examined water with such properties is without any presence of pathogenic micro-organisms. One of the secrets of longevity is the microbiological purity of the water and the availability of the following minerals – Calcium (Ca), Magnesium (Mg), Zinc (Zn) and Manganese (Mn).

In many areas the long-livers and centenarians consume mineral water rich in Potassium (K) and Sodium (Na) [25,26]. The six indicated minerals support the balance in the human body and metabolism, and antioxidant effects occur

[27,28]. Recent studies in compliance with Ordinance No 9 / 2001 are conducted of mountain spring water, Dolnata Cheshma, Teteven. Results are given in Table 2.

Researches were performed for the effects of the clinical parameters of long living people and water parameters [29-33]. Water in the human body has a spectrum for the life like information bearer. For the control group of healthy people the value of the spectrum of the largest local maximum is at -0.1387 eV or at a wavelength of 8.95  $\mu\text{m}$  [34]. For the group of people in a critical state and the patients with malignant tumors, the values of the spectrum of the largest local maximums shift to lower energies compared with the control group. Local extremum at 8.95  $\mu\text{m}$  is expressed in mountain spring waters [23,35,36].

#### 4. CONCLUSION

In the present article an analysis is made of examinations according to No 9 / 2001, Official State Gazette, issue 30, and decree No 178 / 23.07.2004. Researched is the physicochemical composition with 32-33 parameters, and additionally included are Hydrocarbonates ( $\text{HCO}_3^-$ ), Carbonates ( $\text{HCO}_3^-$ ) and Potassium (K).

In many areas the long-livers and centenarians consume mineral water rich in Potassium (K) and Sodium (Na). The six indicated minerals support the balance in the human body and metabolism, and antioxidant effects occur.

One of the greatest treasures of Bulgaria are the mountain spring and mineral waters. Known brands are – Gorna Banya, Bankya, Hissar, Devin, Baldaran, Bachkovo and others.

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#### COMPETING INTERESTS

Author has declared that no competing interests exist.

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