Analytical and human biological studies on Hungary's medical waters

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Introduction

Hungary is especially rich in thermal waters. Its resources can be considered significant even in the world-scale. The formation of the Pannon basin started appr. 10 million years ago, in the pliocene epoch. The slowly submerging basin was overflown by the Pannon sea. As a consequence of the tectonic movements (lifting and submerging of strata), water erosion and accumulation, the ancient form of the present hydrological system appeared after Pannon era in the upper pliocene.

Hungarian spas with upper-pannon aquifers

- Hungarian thermal waters are relics of the Pannon sea.
- We have more than thousand wells giving thermal waters with temperature of >30 °C. In the territory of the country 150 thermal medicinal waters and 36 specific (sulfuric,acidic, iodine, etc.) mineral waters can be found. Next figure indicates this abundance.

1-2: national spa (primarily upper pannon or thermal carstic aquifers)
3: regional spa
4: local spa
5: max. possible temperature of upper pannon thermal water (°C)
6: borders of the pliocene upper pannon strata

Utilization of hot springs started more than 2000 years ago.
It has been proved by written sources on Greeks, Romans, Celts and Germans and buildings (ruins). Relatively few data are known on their knowledge about medical effects or therapeutic use of waters.
The first description was done by János Foltz in the 16th century, who wrote in poems on healing effects of Italian and German medicinal waters. It can be considered the first balneological study. Paracelsus thought that water leaches minerals from inside the earth getting healing power. Spas of Eger were mentioned first time in the era of the Hungarian King: Kálmán Könyves.

Criteria:

<table>
<thead>
<tr>
<th>Active ingredient</th>
<th>minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Li⁺</td>
<td>5 mg/l</td>
</tr>
<tr>
<td>S²⁻</td>
<td>1 mg/l</td>
</tr>
<tr>
<td>Br⁻</td>
<td>5 mg/l</td>
</tr>
<tr>
<td>F</td>
<td>1 mg/l</td>
</tr>
<tr>
<td>M-silicic acid</td>
<td>50 mg/l</td>
</tr>
<tr>
<td>Radon activity</td>
<td>137 Bq/l</td>
</tr>
<tr>
<td>Free CO₂</td>
<td>1000 mg/l</td>
</tr>
</tbody>
</table>

Hungary is a European „great power” considering thermal water resources. This fact can be explained by extraordinary geothermal features of the country. Hungary’s got the fifth rank in the world, following Japan, Izland, Italy and France.

On the wells

Thermal and medicinal water can be found in the 80% of Hungary’s territory. The number of registered hot springs (wells) is 1300. The quantity of resources is approximated 4000 km³. 1% of this volume can be mined. This quantity fulfills demands of present consumption during 200 years. Vast majority of resources is located under the Great and Small Plain (Alföld, Kisalföld). Considerable amounts are also located in South Dunántúl, Balaton-mellék, Budai and Bükk Mountains.

Types of medicinal waters based on the chemical analysis

- Simple thermal water:
  - low dissolved solid content
  - Well-known therapeutic effect, esp. On the rheumatic disorders
  - Springs: Budapest: Római Fürdő, Pünkösdfürdő, Csillaghegy, Kics Fűrdo

Only 15% of water supplied by thermal wells is qualified as natural medicinal water, based on:
- Temperature
- Dissolved mineral content
- Biological active ingredient. Content. These parameters should reach the limit of proved therapeutic concentrations. At present 35 spas have officially validated medicinal water.
**Carbonated waters:**
- Also called acidic waters. Free CO₂ >1g/L. Usually sold as mineral waters for drinking, but sometimes also used as medicinal waters.
- Springs: Maconka (Nógrád county), Répcelak, Mihályi.

**Alkaline waters:**
- Contain sodium and bicarbonate ions. Frequently used in drinking cure in gastrointestinal inflammations, hyperacidity, respiratory inflammations. The best known and most effective one is: Salus of Bükkészék.
- Springs: Balf, Békés, Bükkészék, Gypórárosfürdő, Gyula, Makó, Mezőtúr, Nagyszentmiklós, Tökölombó, Szeged, Szécsény, Szolnok, and others.

**Calcic-magnesian waters:**
- Main constituents: Ca, Mg and bicarbonate ions. Applied in the therapy of rheumatic diseases. Carbonated sorts are used in cardiac and gastric diseases.
- Springs: Budapesten Császárfürdő, Lukács fürdő, Ráce fürdő, Rudas fürdő és Gellért fürdő, and elsewhere in the country: Csopak, Esztergom, Kékút, Mohács, Székesfehérvár.

**Chloride or salty waters**
- Contain sodium and chloride ions. Utilized in rheumatic and gynecological diseases or (in drinking cure) in muscosal infections..
- Springs: Cserkeszőlő, Debrecen, Eger, Hajdúszoboszló, Karcag, Sóshartyán, Pesterzsébet, and salty lakes in the Alföld: Dunapataj, Gyopáros, Kakasszék, or Nyíregyháza-sóstó.

**Bitter waters**
- Sulphate gives their characteristic bitter taste
- Glauber salty waters (Na)
- Bitter salty waters (Mg)
- Diluted waters are used in drinking cure in gastric, intestinal, hepatic, biliary diseases. Their laxative action is well-known.
- Springs: Kelemenfürdő és Budafürdő „Hunyadi János”, „Igmándi” or „Míra” in Tiszajenő.

**Ferrugineous**
- Iron is dermally absorbed from the ferrugineous baths. In the iron shortage type of anemia drinking cure is more effective.
- Springs: Clario- and István-forrás in Parád, or Stefánia-forrás in Moha.
Sulfuric waters

- Taking sulfuric bath is suitable to correct negative sulfur-balance of the body. Sulfuric baths have severe effect esp. in rheumatic diseases and some sorts of skin diseases
- Sulfuric springs: „Imre”, „Lukács” „Rudas” in Budapest, Aranyosfürdő, Balf, Erdőbénye, some bore holes of Harkány, Mezőkövesd.

Iodine-bromine waters

- These ions are present together with NaCl. Utilized in gynecological, rheumatic and some types of skin diseases. In drinking cure iodine is highly effective on thyroid gland. Also used in spoonful quantity prescribed by medical doctor. The best-known brand is Jodaqua, bottled in Sóshartyán.
- Springs: Debrecen, és Hajdúszoboszló (hot), Pesterzsébet (cold).

Radioactive waters:

- Contain Radium ions, Radon gas
- Applied in bath, inhalation and drinking cure
- Analgetic effect is well-known
- Effective on the hormone secretion and metabolism.
- Traditionally thought as preventative to ageing.
- Springs: springs of Rudas, Imre, Gellértfürdő, Soó, Miskolctapolcai Hévíz lake. Hévíz lake is the largest thermal lake of the world. Natural protection area and medicinal spa (Hévízgyógyfürdő).

Physiological effects of balneotherapy

- Opening peripheral vessels
- Increase in circulating blood volume
- Decrease muscle pain
- Increase in excretion
- Beneficial alkaline shift of tissue pH
- Decrease in urine acid content of the body

What type of diseases can be treated by the balneotherapy?

- chronic inflammation of joints
- multijoint calcification
- disorders with vertebral rigidity
- chronic respiratory, gastrointestinal diseases
- chronic colon inflammation
- chronic gynecological inflammations
- metallic intoxications
- arthritis
- postoperative and posttraumatic disorders

Advices, proposals

- Most suitable period for taking bath is before noon, but not directly after having an abundant breakfast.
- Suitable temperature and duration of bathing is individual, depending on the condition of the patient and type of the basic disease (prescribed by the specialized physician).
- Generally, taking bath in a water of 38 °C should not exceed 10 min. Swimming is severely avoidable.
- In a 34-35 °C water swimming is possible, but not optimal for serious sports activity.
- Hypotension can be promoted by hot water!
• Fever conditions do not allow to go to swimming pool or take bath.
• In the recovery stage of ischiac disease specialist should prescribe taking bath because of the risk of recurrence.
• In the 4-5th day of spa therapy „spa reaction” or „spa crisis” may appear. Symptoms include malaise, fever, tachycardia, headache, fatigue, insomnia and pain. An acute flare-up of a dormant condition may occur. In some cases, medication may be required to control symptoms, and traditionally, spa treatment is reduced or temporarily suspended during this period.
• Spa therapy is more than balneotherapy. Bathing may be completed with physical exercises, sun and air bathing, etc.

Mode of action of taking bath in medicinal water

Actions are basically: physical and chemical.

Practice utilizing the physical actions of medicinal water is called hydrotherapy. Buoyancy of water decreases body weight that can be promoted by mineral content. The movements of the body are considerably easier, meanwhile the patient is exposed to beneficial effects of pressure, flow, temperature. Hydrotherapeutic treatments: weight bath (Hungarian innovation), underwater Vichy massage, aquatic physical exercises.

Chemical effects of medicinal waters

Beneficial mineral substances dissolved in water are absorbed through the skin causing diverse effects depending on their chemical features. Balneology is the science that deals with these actions.

Application fields of medicinal waters

From point of view of application two main categories of medicinal waters can be distinguished:
- for external use (baths)
- also for internal use (consuming, drinking cure)

Beside thermal and medicinal water production, bottling and commerce of water were also traditional practice. Their brand names were reflected to the name of the spring. In Budapest carbonated waters were distributed in 1.5 L bottles under the name of Harmatvíz and Margitszigeti Chrystalline water.

Sodium and potassium contents of alkaline waters are high. Sodium-bicarbonate in the stomach neutralizes gastric juice in the treatment of diabetes. Upon consumption decreases in serum glucose level, and increases uric acid dissolving capacity of the urine. Drinking cure weakens or completely prohibits symptoms of urticaria.
Ca content is high in calcic-magnesian waters. There is 1 kg of Ca in the human body, 99% of it is located in the bones. The foetus and the baby mobilize the mother’s lime during pregnancy and lactation. Lime shortage leads lime-poor teeth and bones (caries, bone-softening). Daily requirement of Ca is 1-1.5 g. Ca can only act together with phosphate, otherwise is excreted with urine and feces. Calcic waters have anti-inflammatory action utilized in intestinal inflammation with diarrhea (thickening effect on the excretum). Traditional observation is the diuretic action.

**Chloride (salty) waters**

- are diluted in the stomach. The dilution process is slow. Sodium chloride in waters act both on the mucosal inflammatory processes and secretion of gastric juice.

**Ferrugineous waters.**

- In mineral waters the iron is present in its bivalent absorbable form (ferro-). Absorbed iron is stored in the liver and spleen and circulates as ferroglobulin in blood. Ferrugineous waters are traditionally used in treatment of anemia. Intake of 10 mg/day is enough, so waters containing 20-30 mg/L are useful.

**Sulfuric waters**

- Sulfuric waters are weak laxatives. Cold water decreases the bile excretion, consumption of warm water increases it. Sulfur is essential in detoxication process in the liver. Drinking cure decreases blood pressure, increases activity of the respiratory centre. Sulfur opens blood vessels in the upper respiratory tracts. Heavy metals are excreted via feces combined with sulfur. Digestion is improved after drinking sulfuric waters.

**Iodine-bromine waters.**

- This type of water can only be consumed under medical control. Iodine has been traditionally utilized in the treatment of hypertonia and atherosclerosis. Iodine action on thyroid gland is best known. Bromine waters contain low Br concentrations, their medical significance is limited.

**Iodine-bromine waters.**

- Healing effect of radioactive waters caused by radiation energy. Low absorbed doses do not have pathogenic effects. Radiation energy mainly acts on cellular level. Radon gas (emanation) is a decay product of radium. Majority of natural radioactive springs are radon containing waters. They emit short half-life, low intensity, non-adverse effect radiation. Bottled waters have low mineral content. Drinking cure needs medical control.
Studies on the most important medical waters of Hungary

Supported by Hung. Balneological Soc.

Prof. L. Papp, J. Szuetta

Analysis of main elements in especially important 8 Hungarian spa waters

First part of the study was focused on analysis of main – physically, phisico-chemically or chemically – important elements. During the study, beside different physico-chemical examinations, Na, Mg, K, Ca – contents were determined in the 8 spa waters. Analysis of some anions are also performed: \( \text{HCO}_3^-, \text{Cl}^-, \text{SO}_4^{2-}, \text{F}^-, \text{I}^- \).

Sampling sites and in situ analyses

<table>
<thead>
<tr>
<th>Sampling site</th>
<th>Location of sampling within the spa</th>
<th>Temp. of bathing water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debrecen</td>
<td>Original spa water from treatment baths, cooled to 31 °C</td>
<td>35.0 °C</td>
</tr>
<tr>
<td>Hajdúságszászló</td>
<td>Basin, before taking bath</td>
<td>33.6 °C</td>
</tr>
<tr>
<td>Eger</td>
<td>Treatment bath, during bathing</td>
<td>31.5 °C</td>
</tr>
<tr>
<td>Egerszalók</td>
<td>Directly from spring effluent</td>
<td>44.8 °C</td>
</tr>
<tr>
<td>Bukfürdő</td>
<td>Effluent pipe from the well</td>
<td>33.0 °C</td>
</tr>
<tr>
<td>Hévíz</td>
<td>From wooden bath cabin built on the lake</td>
<td>32.5 °C</td>
</tr>
<tr>
<td>Harkány</td>
<td>From mixed water in cont. of 600 m3</td>
<td>33.5 °C</td>
</tr>
<tr>
<td>Cserkeszőlő</td>
<td>Out of district spring</td>
<td>33.0 °C</td>
</tr>
</tbody>
</table>

Some important physico-chemical parameters of waters

<table>
<thead>
<tr>
<th>Sampling site</th>
<th>pH</th>
<th>Conductivity ( \mu \text{S cm}^{-1} )</th>
<th>dissolved ( \text{O}_2 ) mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Debrecen</td>
<td>8.20</td>
<td>2310</td>
<td>3.66</td>
</tr>
<tr>
<td>2. Hajdúságszászló</td>
<td>8.10</td>
<td>2582</td>
<td>2.78</td>
</tr>
<tr>
<td>3. Eger</td>
<td>7.62</td>
<td>1470</td>
<td>1.77</td>
</tr>
<tr>
<td>4. Egerszalók</td>
<td>7.80</td>
<td>1835</td>
<td>6.5</td>
</tr>
<tr>
<td>5. Bukfürdő</td>
<td>7.58</td>
<td>7310</td>
<td>( \Delta ) 0.94</td>
</tr>
<tr>
<td>6. Hévíz</td>
<td>7.26</td>
<td>555</td>
<td>( \Delta ) -</td>
</tr>
<tr>
<td>7. Harkány</td>
<td>8.26</td>
<td>850</td>
<td>( \Delta ) -</td>
</tr>
<tr>
<td>8. Cserkeszőlő</td>
<td>7.29</td>
<td>2073</td>
<td>( \Delta ) -</td>
</tr>
</tbody>
</table>

\( \Delta \): Waters containing reductive S\\(^2\)-ion, therefore do not contain dissolved oxygen

Some important physico-chemical and chemical parameters

<table>
<thead>
<tr>
<th>Sampling site</th>
<th>mmol/l</th>
<th>mmol/l</th>
<th>mg/l</th>
<th>mg/l</th>
<th>mg/l</th>
<th>mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debrecen</td>
<td>23.7</td>
<td>2.8</td>
<td>1448</td>
<td>15.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hajdúságszászló</td>
<td>26.6</td>
<td></td>
<td>1621</td>
<td>9.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eger</td>
<td>5.8</td>
<td></td>
<td>354</td>
<td>48.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Egerszalók</td>
<td>5.4</td>
<td></td>
<td>329</td>
<td>64.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bukfürdő</td>
<td>119</td>
<td></td>
<td>7259</td>
<td>76.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hévíz</td>
<td>7.6</td>
<td></td>
<td>464</td>
<td>92.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harkány</td>
<td>9.5</td>
<td>1.5</td>
<td>580</td>
<td>53.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cserkeszőlő</td>
<td>22.7</td>
<td></td>
<td>1385</td>
<td>17.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Na, Mg, K, Ca contents in medicinal waters tested

<table>
<thead>
<tr>
<th>Sampling site</th>
<th>Na mg/l</th>
<th>Mg mg/l</th>
<th>K mg/l</th>
<th>Ca mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debrecen</td>
<td>2200</td>
<td>8.3</td>
<td>26.4</td>
<td>12.0</td>
</tr>
<tr>
<td>Hajdúságszászló</td>
<td>1200</td>
<td>4.6</td>
<td>7.4</td>
<td>12.9</td>
</tr>
<tr>
<td>Eger</td>
<td>7.0</td>
<td>18.0</td>
<td>1.8</td>
<td>216</td>
</tr>
<tr>
<td>Egerszalók</td>
<td>60</td>
<td>24.2</td>
<td>14.2</td>
<td>120</td>
</tr>
<tr>
<td>Bukfürdő</td>
<td>4650</td>
<td>46.6</td>
<td>3700</td>
<td>562</td>
</tr>
<tr>
<td>Hévíz</td>
<td>24.0</td>
<td>34.5</td>
<td>8.8</td>
<td>192</td>
</tr>
<tr>
<td>Harkány</td>
<td>185</td>
<td>13.6</td>
<td>16.0</td>
<td>53.0</td>
</tr>
<tr>
<td>Cserkeszőlő</td>
<td>650</td>
<td>1.5</td>
<td>12.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>
Evaporation residue and TDS

Their importance:
Deliver information on the quantity of dissolved minerals
Confirm results of the cation and anion analysis
Reaction kinetic reasons (diffusional pressure can alter absorption of main elements)
Examination was carried out both at 105 and 180 °C
(105 is used in water analysis, and 180 is used in mineral water analysis, since some substances lose their crystalline water only at 180 °C)

Results of analysis of some important anions

<table>
<thead>
<tr>
<th>Sampling site</th>
<th>Cl</th>
<th>SO₄²⁻</th>
<th>F</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Debrecen</td>
<td>2750</td>
<td>2.4</td>
<td>1.59</td>
<td>&lt;10 µg/l</td>
</tr>
<tr>
<td>2. Hajdúszoboszló</td>
<td>38</td>
<td>2.4</td>
<td>1.33</td>
<td>&lt;10 µg/l</td>
</tr>
<tr>
<td>3. Eger</td>
<td>40</td>
<td>5.3</td>
<td>0.37</td>
<td>&lt;10 µg/l</td>
</tr>
<tr>
<td>4. Egyszalók</td>
<td>50</td>
<td>18.5</td>
<td>0.94</td>
<td>&lt;10 µg/l</td>
</tr>
<tr>
<td>5. Bükfürdő</td>
<td>2110</td>
<td>47.3</td>
<td>2.17</td>
<td>&lt;10 µg/l</td>
</tr>
<tr>
<td>6. Hévíz</td>
<td>130</td>
<td>15.2</td>
<td>0.60</td>
<td>&lt;10 µg/l</td>
</tr>
<tr>
<td>7. Harkány</td>
<td>190</td>
<td>2.5</td>
<td>2.26</td>
<td>&lt;10 µg/l</td>
</tr>
<tr>
<td>8. Cserkeszlő</td>
<td>40</td>
<td>2.4</td>
<td>1.64</td>
<td>&lt;10 µg/l</td>
</tr>
</tbody>
</table>

TDS of analysed waters at 105 and 180 °C

<table>
<thead>
<tr>
<th></th>
<th>TDS 105 °C-on</th>
<th>TDS 180 °C-on</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debrecen</td>
<td>5860</td>
<td>5620</td>
</tr>
<tr>
<td>Hajdúszoboszló</td>
<td>1780</td>
<td>1620</td>
</tr>
<tr>
<td>Eger</td>
<td>643</td>
<td>-</td>
</tr>
<tr>
<td>Egyszalók</td>
<td>320</td>
<td>-</td>
</tr>
<tr>
<td>Bükfürdő</td>
<td>11940</td>
<td>10420</td>
</tr>
<tr>
<td>Hévíz</td>
<td>500</td>
<td>300</td>
</tr>
<tr>
<td>Harkány</td>
<td>600</td>
<td>360</td>
</tr>
<tr>
<td>Cserkeszlő</td>
<td>1622</td>
<td>1140</td>
</tr>
</tbody>
</table>

Evaluation of chemical analyses on water samples

Debrecen:
- Rich in minerals, alkali-chloride (sodium-chloride) bicarbonate, fluoride type of water
- Extremely high mineral (NaCl) content is confirmed by the results of specific electric conductivity (and evaporation residue) measurement.

Hajdúszoboszló:
- Rich in minerals, alkali-chloride (sodium-chloride) bicarbonate, fluoride type of water
- Extremely high mineral (NaCl) content is confirmed by the results of specific electric conductivity (and evaporation residue) measurement.
Eger:
- Poor in Na and K but rich in Ca and Mg. Evaporation residue is not much. Medicinal water status is based on the Rn content.

Egerszalók:
This medicinal water is Ca, Mg, bicarbonate type thermal water, erupting from 410 m. Also contains Na and m-silicic acid. During sampling in the eruption zone sulfuric bacteria were identified indicated by the excreted yellow sulfur.

Bükfürdő:
- Rich in minerals, alkali-chloride (sodium-chloride) Ca-, Mg-bicarbonate, fluoride type of water
- This water showed the most evaporation residue and highest m-alkalinity (that is bicarbonate content).

Hévíz:
- Lake Hévíz is the largest surface hot water medicinal lake of Europe, showing weak radioactivity, contains Ca and Mg bicarbonates and is reductive. Colloidal sulfur can be detected in the water (possibly from COS)

Cserkeszőlő:
- Alkali-bicarbonate medicinal water with considerable evaporation residue. Conductivity also indicates the high mineral content

Human biological study on the analysed medicinal waters
Supported by Hung. Balneological Soc.
Prof. L. Papp, J. Szuetta
Human biological study on the analysed medicinal waters

Are main elements of waters (Na, K, Ca, Mg) absorbed by the human body as measured by analytical (ICP OES) methods.

The 8 most important spa waters contain suitably high concentration of Na, K, Ca and Mg which may cause significant increase the cation levels in treated patients.

If there is any correlation in concentration upon taking bath in patients’ blood, the main elements can be primarily considered.

Sampling of patients

Diet of patients

Dietetic experts worked out a special diet for patients containing only the essential quantity of elements under study. It is important because the 4 main elements are present in the blood with some magnitudes higher concentrations. Patients were allowed to submerge only for 40 minutes occasionally.

Elements of blood sampling of patients

Blood samples were taken into vacutainer tubes
  a.) before taking bath
  b.) after the first bath
  c.) after the tenth bath

Vacutainer tubes contained 1.26cm³ 0.105 M Na-citrate anticoagulant.
Na-citrate was also measured by us, results confirmed the official data. Na content was then considered as constant.

Sampling error

Blood sampling was frequently performed in non-professional way. These errors amplified our work considerably. Sometimes it caused irreparable errors leading useless results.

Frequent errors during blood sampling

- In the vacutainer tubes the exactly adjusted vacuum allows to collect similar volume of blood (5 cm³). Frequently the needle was pulled out earlier and less blood was taken. Therefore Na contents and dilution were not constant.
- Lack of homogenation led to partial coagulation. These samples were tried to homogenate by ultrasound with limited success.
- After freezing samples were kept at room temperature for longer periods, the tubes broke causing partial loss of samples. Residual blood samples were not representative due to inhomogeneity.
- Volumes of samples taken were sometimes to small for the analysis.

To correct these errors Fe content was measured in all samples. The results were normalized to Fe. However Fe content is also subject of interindividual differences.
Results of the study

- During measurements patients’ samples taking bath according to the „a-b-c” protocol. Theoretically we had suitable volumes for the analyses.
- To correct the sampling error, the iron of blood hemoglobin was measured. It was used as internal reference, since it is well measurable parameter. Unfortunately it has considerable standard deviation, but it was not measurable in the water samples or its concentration was negligible as compared to the 4 main elements.
- By using this calculation method, based on the data, taking the value measured before bathing as 100 %, it was possible to test the accumulation or decrease of the 4 elements.

Evaluation, consequences

- The present scientific background is not really developed yet to answer the basic question, that is, what ionic substances, in which quantity is absorbed by the human body, if any.
- It would only be possible, if mineral contents of consumed foods and absorbable elements from water during taking bath were within the same range. (When foods and water contain same quantities.)

Evaluation, consequences

- Physiological mode of action of medicinal waters is not completely known even nowadays. Therefore it is fully understandable that waters of extreme temperature is subject of beliefs.
- The placebo effect has an important and significant role in the balneotherapy, which can be avoided by using double blind studies in the qualification process. Knowledge is also limited on the therapeutic effects of the particular constituents in particular diseases.
- Hungary has a great interest in solution of these problems in order to have a real answer on the questions arisen in the field of balneotherapy. These questions involve the possible correlations among the particular ions, elements, substances and the possible medicinal effects.

Köszönöm a figyelmet!