THE ELECTRICAL CONDUCTIVITY OF VARIOUS NATURAL STILL WATERS

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Abstract

Water is the main single component of the body as an essential element of all tissues. Daily intake of water is about 1 ml per kcal energy intake, representing quantitatively also the main component of intake of external matter. Studying the physico-chemical properties of several still waters (pH and electrical conductivity) we found important differences between various still waters extracted from various natural surfaces in Romania. According with these parameters, Keia from Romania and Vittel from France seems to be the most appropriate for utilization in a large group of population.

Introduction

Water is one of the simplest molecule which is essential for life. By its skewed tetrahedral geometry, electrical dipole charges is not uniformly distributed about the water molecule. By at conformation it solubilizes and modifies the proprieties of biomolecules and their conformation in solutions such as nucleic acids, proteins and carbohydrates, by forming hydrogen bonds with their polar functional groups [1].

Water is the largest single component of the body as an essential element of all tissues. As a solvent, it make many solutes available for cell functions, is a medium for all chemical reactions . Water is a substrate in various metabolic reactions and a structural component ensuring the specific form of cells. For that, a loss of only 2% of body water might impair several physiological functions. A decrease with 10% of body water causes severe disorders and a loss 20% of body water may cause death.

The total water of an adult human body (40-60%) is higher in men (cca 55%) than in women (cca 45%).The content in water is higher (cca 70%) in children and lower in old ages (cca 40%). Because the adipose tissue contain a smaller percentage of water (cca 20%), the obese individuals have a lower water content than slim individuals (the free fat mass contain about 72% water). For that, the women (with a higher fat mass) contain a lower quantity of water than men.

A man weighing 75 kg will contain cca 42 l of water, from which 28 l intra-cellular water (about 65% of all quantity of body water) whereas 14 l is extracellular water: 11.2 l in interstitial space, and 2.8 l in intra-vascular compartment.

In normal conditions, the daily input of water is about 1 ml per 1 kcal energy intake, corresponding to 35-40 ml/kg body weight, or

1124 ml/m^2 body surface. This translates into approximately 35 ml/kg of usual body weight in adults, 50-60 ml /kg in children, and 150 ml/kg in infants

From a total input of 2500 ml water of an adult individual living in a temperate climate, with a moderate physical activity (35 kcal/body weight/day), the unadjustable fraction of water is represented by the „invisible" water present in „solid" foods (cca 800 ml from vegetables and meet) and the endogenous water (cca 300 ml) resulting from the energy releasing biochemical reactions of protein, lipid and carbohydrate molecules. The burning of these fuels end with production of ATP, CO_2 and H_20 molecules. The rest of water input of 1300 ml is represented by the intake of various liquids: water, tea, milk, soups , jus fruits or other drinks.

Study of some physico-chemical properties of several still waters

A quite slight ability of water molecule to dissociate, is enough to became of central importance for life on earth. Since water can act both as an acid and as a base, its ionization may be represented as an intermolecular proton transfer, forming a hydronium ion (H_3O^+) and a hydroxide ion (OH^-):

$H_2O + H_2O = H_3O^+ + OH^-$

An *acid* is any substance which tends to release hydrogen ion in solution, whereas a *base* is any substance able to accept hydrogen ions in solution. Acid-base balance is a dynamic equilibrium state of hydrogen ion concentration. A low blood pH indicates a high hydrogen ion concentration, whereas a high pH value indicates a lower hydrogen ion concentration. By its intrinsic characteristics, water molecule is essential for the regulation of the acid-base balance [2, 3, 4]. As can be seen in Table 1, pH of various still waters can be in acidic or alkaline ranges according with the content both in HCO3- and other chemical compounds. This physico-chemical characteristic must be taken into account when we indicate their utilization according with the presence of various diseases, especially reno-ureteral-vesical lithiasis.

Table 1: The dependence of still water's *p*H from concentrations of HCO_3^- is only relative

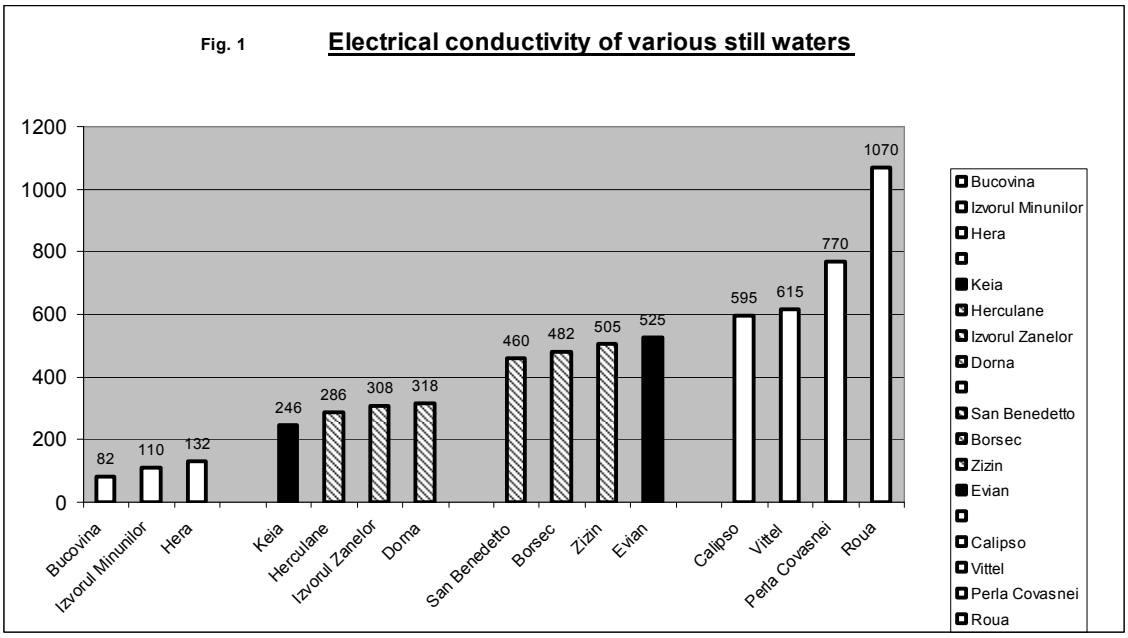
Still water	HCO_3^- (mg/l)	*p*H
Keia	149	7,83
Vittel	248	7,8
Dorna		7,7
Evian	360	7,2
Bucovina	73,2	7,03
Herculane	170,8	7
Perla Covasnei		6,2

By their composition, the tap natural waters might have specific biological effects, some of them being of therapeutic value.

In Table 2 we give the results regarding the electrical conductivity (μSiemens/cm) of several natural mineral waters, majority from Romania, but also few from other European countries.

Table 2: Electrical conductivity of several natural mineral waters.

Still water	Conductivity ($\mu S/cm^2$)
Roua	1070
Perla Covasnei	770
Vittel	615
Calipso	595
Evian	525
Zizin	505
Borsec	482
San Benedetto	460
Dorna	318
Izvorul Zanelor	308
Herculane	286
Keia	246
Hera	132
Izvorul Minunilor	110
Bucovina	82



As can be seen, in Fig 1, the electrical conductivity has been divided in four categories, according to the value of this parameter: below 150 µS; between 150 and 350 µS/ cm; between 350 and 550 µS/ cm, and over 550 µS/cm.

It is obvious that a very low conductivity (< 150 µS/cm) or a very high conductivity (>550 µS) might have some limitations to be

used either in infants or in old ages (over 65 years), when the physiological homeostatic mechanisms are, in the first situation, not complete maturate or, in the second condition, deteriorated by senescence or various affections.

As result from Fig. 1, the two middle groups of natural mineral waters, starting with Keia and ending with Evian, could be used in all age groups, including infants and old individuals. On contrary, the waters with lowest and highest electrical conductivities should be used with prudence in the sensitive age groups.

Discussion

Apart of quantity of water intake its quality is also important. Because the poor quality of tap water, many people use for drink or to use for various preparations (tea, coffee) some natural mineral water. The knowledge of its chemical composition and physical proprieties is important for children, old people, or from those suffering from various diseases.

One of the physico-chemical propriety of biological liquids is its electrical conductivity, depending on its electrolytes content. Electrolytes can be simple inorganic salts of sodium, potassium, or magnesium or complex organic molecules. They dissociate into positively and negatively charged ions (cations and anions) when dissolved in water. (Whitmire, 2000).

Natural water analyzed physically and chemically is not pure, as it contains salts, various particles in suspension and gases. The chemically pure water is neutral (pH = 7) and has a very low electrical conductivity. From this point of view, water has a particular place in comparison with other biological or non-biological liquids. In a very pure state is a very good dielectric, but the watery solution of electrolytes are much butter conductor of electricity then the solution of the same substances in other solvents.

Conclusions

Drinking water must be of high quality from the point of physical, chemical, biological and bacteriological indicators. In some cases, natural waters (mainly the surface waters) must undergo treatment procedures in order to reach the proper quality according to the limits provided by national or international standards. On contrary, the mountain spring waters are, generally, proper to be used without any supplementary treatment. For instance Keia water is captured at 1300 meters altitude, and according to its pH and electrical conductivity, appears to be the best still water on our continent.

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