Natural Mineral Spring Waters

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Natural mineral spring waters are rich in different territories in most world areas. The waters have saline compositions that reflect their geological origin and are used for human health (often under medical prescription). However, scarce scientific attention has been dedicated to the use of these waters for athletes.

Keywords: Natural Mineral Spring Waters ; Athlete ; Athletic Performance

1. Introduction

Water makes up 50–70% of body mass and is distributed in the intracellular (65%) and extracellular (35%) spaces [1]. Physiologically, our body requires a minimum of 4 to 6 glasses of water daily, also gained by solid food. Over the years, international institutions such as the European Food Safety Authority (EFSA) or the National Research Council have issued guidelines on daily water intake: 2.0–2.4 L/day are recommended for males and 1.6–2.0 L/day for females [2]. These values must be adjusted depending on climate and level of physical activity. Exercising leads to water and electrolytes loss that must be replenished, and when a subject is dehydrated plasma volume decreases. Tight regulation of blood volume is related to multiple organ systems and is closely associated with electrolytes content and hydration status. Since it is necessary for the constant perfusion of body tissues, the maintenance of plasma volume is crucial to normal multiorgan function. Hence, changes in blood volume can result in different clinical situations such as edema or hypovolemic shock. Several aspects of the hematologic system itself can also be influenced by physical activity [3], for instance, besides the well-known effects on red blood cells, dehydration, hypovolemia, and physical exercise per se generate a catecholamine response that in turn induces thrombocytosis and affects hemostatic function [4]. On the other hand, inherited abnormalities of the blood, including platelet disorders [5] can manifest in athletes under stress [6] conditions.

Traditionally, coaches tell athletes that thirst is not a good indicator of hydration status, because “once you’re thirsty, you’re already dehydrated”. The American College of Sport Medicine (ACSM), in their fluid replacement position stand, highlighted that “perception of thirst [.] cannot be used to provide complete restoration of water by sweating” and that “athletes should start drinking early and at regular intervals [.] or consume the maximal amount that can be tolerated” [7]. ACSM suggested for athletes a water intake plan of about 500 mL of fluids 2 h before exercise, followed by an interval hydration during exercise every 15–20 min, especially in ultra-endurance sports at high humidity and temperature. Indeed, a condition of water deficit negatively impacts sport performances. Therefore, customizing a drinking plan for athletes means preventing dehydration during physical activity and restoring the initial hydration status in the post-exercise recovery.[8][9][10]. Environmental conditions influence exercise capacity and athlete performance. When preparing a competition, athletes and their technical staff must consider meteorological factors as temperature and humidity, indoor or outdoor field.

To face fluid imbalance during sport performance, studies on the so-called “sports drinks” developed. Sports drinks were created to provide quick replacement of fluids, electrolytes, and carbohydrates during physical activities [11]. Generally, with these beverages at low carbohydrate concentration (<10%), athletes can replace sweat losses, restore the hydration status, and supply a little source of carbohydrates before and during exercise [12]. As expected, however, the “perfect mix” has never been found, not to say of other frequent accompanying side problems such as palatability or gastrointestinal discomfort.

Different territories in most world areas are rich in drinking Natural Mineral Spring Waters (NMSWs) with saline compositions that reflect their geological origin and that are used for human health (often under medical prescription). While most scientific literature is focused on carbohydrate/electrolyte composition of artificial sport beverages [13][14][15], scarce scientific attention has been dedicated to the mineral composition(s) of natural spring waters as related to the average hydro-saline requirements of the different athletic performances. Indeed, after the European directive 2009/54/EC of the European Parliament and of the Council of 18 June 2009 on the Exploitation and Marketing of natural mineral

waters [16], then adopted by European Member States, it is possible to take advantage of a natural mineral waters classification—from low to high mineral content with different dissolved salts—and a specific nomenclature based on the prevailing minerals (e.g., bicarbonate water, if the content of bicarbonate is more than 600 mg/L or magnesium water, if the magnesium content is greater than 50 mg/L, etc.) NMSWs—differently from tap water—ultimately contain a specific mix of natural elements, with associated beneficial effects often generically reported on the bottle's tag as water properties ("suitable for a low-sodium diet", "may be laxative", "may be diuretic", "promote digestion", etc.)

Given this background, we asked if there was sufficient scientific data to predict that the biological properties of specific NMSWs could optimally respond to the physiological needs of athletes in relation to their specific sport activity and performance. For example, it was shown that after a prolonged aerobic exercise, the rehydration of athletes with a natural and moderately mineralized water was more effective in inducing recovery and leg power compared to plain water [17]. As shown by Chycki et al. (2018) [18], a mineral alkaline water enhances the hydration status of combat sport athletes compared to commercial table water. The same authors [19] also proved that alkaline, low mineralized waters had a positive impact on hydration status in response to high-intensity interval exercise. A rationale then exists for the idea of a hydration/rehydration plan with specific NMSW, to give the optimal hydration status before the competition and to restore fluid balance during and at the end of it.

2. Natural Mineral Spring Waters (NMSWs) and Athletic Performance

According to the European directive 2009/54/EC [16] the natural mineral waters are primarily defined as "microbiologically wholesome water […] originating in an underground water deposit and emerging from a spring tapped at one or more natural or bore exits". The original nature (mineral content) and purity at source must be preserved and unaltered after bottling. To define water as "natural mineral", there are some requirements and criteria: a geological report of the catchment site, its altitude, origin, and nature of the terrain; physical and chemical characteristics (water temperature at source, ambient temperature, dry residues at 180° and 260°, type of minerals, etc.) are also required, as long as microbiological analyses to test the absence of parasites or pathogenic micro-organisms. If biological properties of NMSWs on different organ systems are established (e.g., urinary [20], digestive [21], respiratory [22], and gastrointestinal [23] tracts; bone [24]; and skin [25][26]), these must be confirmed by clinical and pharmacological analyses that state them as specific characteristics of each particular NMSW. Several of these parameters contribute to the classification of natural mineral waters: the 180 °C fixed residue, for example, defines the water mineral content (very low: <50 mg/L), low (<500 mg/L), medium (from 500 mg/L to 1500 mg/L) and high (>1500 mg/L). However, since the biological effects of NMSWs are mainly related to their mineral content, their most common classification is based on the mineral element(s) present in higher proportions, as detailed in Table 1.

Table 1. Nomenclature of natural mineral waters classified according to their prevailing mineral content.

Nomenclature	Criteria
Bicarbonate	**Bicarbonate content greater than 600 mg/L**
Sulphate	**Sulphate content greater than 200 mg/L**
Chloride	**Chloride content greater than 200 mg/L**
Calcium	**Calcium content greater than 150 mg/L**
Magnesium	**Magnesium content greater than 50 mg/L**
Fluoride	**Fluoride content greater than 1 mg/L**
Iron	**Bivalent iron content greater than 1 mg/L**
Acidic	**Free carbon dioxide content greater than 250 mg/L**
Sodium	**Sodium content greater than 200 mg/L**
Suitable for a low-sodium diet	**Sodium content less than 20 mg/L**

Modified from Directive 2009/54/EC of the European Parliament and of the Council of 18 June 2009 on the exploitation and marketing of natural mineral waters, Official Journal of the European Union, 26 June 2009 [16].

Authors [27][28][29][30] reviewed the existing literature of drinkable NMSWs and their biological properties. Given the mineral content of a specific water and the pre- and rehydration needs related to a specific sport performance, it appears conceivable to match different types of mineral waters to sport activities and physiological needs of athletes.

3. Conclusions

It has been established that it is necessary to start exercising optimally hydrated, thus with optimal plasma electrolytes levels, to prevent a body weight loss of 2% or more. However, athletes do not usually follow a prehydration customized plan and likely start performance under uncontrolled hydration conditions. An adequate rehydration plan during and after the performance, customized to the individual sweating rate, beverage availability, exercise duration and intensity, and environmental conditions is necessary as well, to preserve athlete's health and physical fitting. To this end, the presence of electrolytes into the water is essential to compensate fluid loss during exercise.

NMSWs are a natural source of water-dissolved minerals that can optimize both pre- and rehydration needs of athletes. Although this topic deserves a higher scientific attention, available literature supports the idea that specifically chosen NMSWs can integrate athlete's diet replenishing sport-related fluid and electrolyte deficits. Magnesium waters optimize anaerobic performances, favouring muscle strength and power in response to load effort; bicarbonate and/or alkaline waters optimize endurance sports (running, cycling, long-distance and long-duration events, etc.), where the performance is strongly dependent on efficient control of pH levels and fatigue. The presence of calcium ions in both magnesium and bicarbonate waters favours muscle contraction, while sodium content should be accurately controlled, according to the individual needs.

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