

## Comparison of Natural Mineral Water From Agrı Province With Sports Drinks

İbrahim Hakkı ÇAĞIRAN<sup>1</sup>, Dursun Alper YILMAZ<sup>1</sup>, Mehmet Emin ATAY<sup>2</sup>, Gökhan DEGE<sup>1</sup>

DOI: <https://doi.org/10.38021asbid.1161264>

ORIGINAL ARTICLE

<sup>1</sup>Ağrı İbrahim Çeçen University, Faculty of Health Science, Ağrı/Türkiye

<sup>2</sup>Ağrı İbrahim Çeçen University, Doğubayazıt Ahmed-i Hani Vocational School, Ağrı/Türkiye

### Abstract

Dehydration emerges due to lack of fluid balance in the body. In addition, minerals such as sodium, potassium, calcium, and magnesium are lost because of dehydration. Athletes lose fluids and electrolytes through sweating during exercise, and replacing the lost fluid and electrolytes is crucial for the continuity of their sports performance. Sports drinks can be consumed by athletes to replace fluid and electrolytes lost during exercise and to improve performance. During this period, consumption of sports drinks minimizes dehydration by restoring the lost mineral and fluid balance. However, the composition of these products, their active ingredients, their effects on sports performance, and their risk factors are matters of debate. This study was carried out in order to compare sports drinks with the local mineral water that comes out naturally in the province of Agri. The mineral determinations of the local mineral water were made using Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) instruments. As a result of the analyses, the average sodium (Na) value in the local mineral water was 26.6 ppm, and the magnesium (Mg) average was 7.782 ppm. No potassium (K) mineral was detected in Agri local mineral water. Calcium (Ca) mineral average was found to be 65.04 ppm, iron (Fe) mineral average 0.0068 ppm, and zinc (Zn) mineral average 0.02457 ppm. Agri natural mineral water contains minerals in similar amounts to sports drinks. Considering these values, it can be a natural alternative to sports drinks if potassium mineral and glucose is added to its content, so it can be an alternative to sports drinks.

**Keywords:** Dehydration, Ergogen, Mineral, Liquid, Athlete

### Corresponding

**Author:** İbrahim Hakkı ÇAĞIRAN  
dzt.ihcagiran@gmail.com

## Ağrı İlinden Çıkan Doğal Maden Suyunun Sporcu İçecekleri İle Karşılaştırılması

### Öz

Vücutta sıvı dengesinin sağlanamaması nedeniyle dehidratasyon durumu ortaya çıkmaktadır. Ek olarak dehidratasyon sonucu sodyum, potasyum, kalsiyum ve magnezyum gibi minerallerde de kayıp yaşanır. Sporcular, egzersiz esnasında terleme yoluyla sıvı ve elektrolit kaybetmektedir ve kaybedilen sıvı ve elektrolitlerin yerine konması spor performansının devamlılığı açısından önemlidir. Sporcu içecekleri, sporcular tarafından egzersiz esnasında kaybedilen sıvı ve elektrolitlerin yerine konması ve performansı artırması amacıyla tüketilebilmektedir. Bu dönemde sporcu içecekleri tüketimi kaybedilen mineral ve sıvı dengesini düzelterek dehidratasyonu minimuma indirmektedir. Ancak bu ürünlerin bileşimi, etken maddeleri, spor performansı üzerine etkileri ve risk faktörleri açısından tartışma konusudur. Bu çalışma Ağrı ilinde doğal olarak çıkmakta olan yerel maden suyunun sporcu içecekleri ile karşılaştırılması amacıyla yapılmıştır. Yerel maden suyu mineral tayinleri İndüktif Eşleşmiş Plazma-Kütle Spektroskopisi (ICP-MS) cihazları kullanılarak yapılmıştır. Analizler sonucu yerel maden suyunda ortalama sodyum (Na) değeri 26,6 ppm, magnezyum (Mg) yerel maden suyunda ortalama 7,782 ppm olarak tespit edilmiştir. Ağrı yerel mineral suyunda potasyum (K) minerali tespit edilmemiştir. Kalsiyum (Ca) minerali ortalama 65,04 ppm, demir (Fe) minerali ortalama 0,0068 ppm ve çinko (Zn) minerali ortalama 0,02457 ppm olarak tespit edilmiştir. Ağrı doğal maden suyu sporcu içeceklerine benzer değerlerde mineral içermektedir. Bu değerler göz önüne alındığı zaman potasyum ve glikoz ilave edilmesi durumunda, yerel maden suyu sporcu içeceklerine alternatif olabilir.

**Anahtar kelimeler:** Dehidratasyon, Ergojen, Mineral, Sıvı, Sporcu

Received:  
12.08.2022

Accepted:  
24.11.2022

Online Publishing:  
28.03.2023

## Introduction

Water, which is defined as the liquid that enables the transport of organic and inorganic substances in the body, is an indispensable nutrient for the continuation of life (Belval et al., 2019; Popkin et al., 2010). Water constitutes 50-70% of the total body mass, 65% intracellular and 35% extracellular (Edelman and Leibman, 1959). Fluid intake is essential for the physiological functions of the body such as modulation of normal osmotic pressure, maintenance of electrolyte balance, and regulation of body temperature (Benelam and Wyness, 2010).

Dehydration, which refers to a deficiency in total body water, can impair the person's ability to participate in physical activities, increasing the risk of urinary system and cardiovascular system diseases (Bradley et al., 2017; Sontrop et al., 2013). The brain regulates cognitive performance and mood, and water makes up about 75% of brain mass. There may be relationships between hydration states and cognitive performance and mood (Zhang et al., 2019). Moreover, dehydration induces loss of minerals such as Na, K, Ca, and Mg. Dehydration is frequently encountered in athletes after long and exhausting competitions (Kerksick et al., 2018a).

Water consumption is of great significance in extreme sports such as marathons, which accelerate the formation of dehydration status (Kerksick et al., 2018a). The severity of dehydration may change depending on the type of sport being played, the intensity and duration of the training, and environmental conditions such as temperature and humidity. The rate of losing water soars especially during periods of high air temperature and periods when athletes play sport for a long duration (Ayan and Kavi, 2016). Failure to provide fluid replacement may result in cramping, fatigue, difficulty in breathing, or even death. In the United States, in the year 2001, the death of a professional football player resulted from a heat stroke (Ayan and Kavi, 2016; Belval et al., 2019). Similarly, a player died in a sports competition held between universities in the same time period. According to a report by the Center for Disease Control and Prevention (CDC), in 1997, a number of deaths because of hunger and dehydration happened in the professional wrestling league due to the desire of the athletes to lose weight quickly (Belval et al., 2019).

Sports drinks are flavored beverages that typically contain a mixture of sugars and electrolytes such as sodium, potassium, and magnesium. They are widely used during sports activities or exercises. They can also be preferred as pre- and post-workout drinks. Sports drink can also be defined as a substance consisting of water and other essential micronutrients to help our body recover from stress and meet physiological needs (Shirreffs, 2009). The main purpose of these drinks is to provide the body with carbohydrates and essential minerals to nourish our tissues and organs during activity and to accelerate the overall recovery process during exercise. A functional sports drink serves to

conserve the level of water in our bodies and to boost athletic performance by inhibiting the occurrence of certain health hazards (Stachenfeld, 2014). The main components of sports drinks are water, salts, and glucose substances, which are further modified with secondary materials such as vitamins, minerals, choline, and other different micronutrients. Thanks to this broad-spectrum content, sports drinks play a major role in regulating energy generation, improving our cognitive and immune systems, and reducing joint pain (Hoffman et al., 2017). For this reason, sports drinks are of great importance for the reduction of symptoms caused by dehydration and the maintenance of the optimal course of performance in athletes.

Natural mineral water is distinguished from other bottled waters by its unique underground geological origin, stable mineral composition, and original purity (Petraccia et al., 2006). To avoid any change in content, natural mineral water should be bottled at its source and undergo only a strictly limited number of processes that are explicitly permitted. According to the geological structures of a geography, there can be great differences in the composition of mineral waters (Kerstetter and Allen, 1990). Therefore, mineral waters have potentially beneficial or harmful effects on health, including bone health. Various mineral waters have been found to produce valuable results for bone metabolism, which is attributed to their Ca content (Bernardes et al., 2022; Vannucci et al., 2018; Wynn et al., 2009). Ca-rich mineral waters have also been shown to be an alternative to dairy products, as the bioavailability of Ca in mineral waters is similar, and possibly even better than dairy products (Vannucci et al., 2018). It has also been illustrated to reduce bone resorption. Along with bicarbonate, mineral cations also seem to play an important role in this process (Wynn et al., 2009).

This study was carried out to compare the local mineral water naturally produced in Ağrı with sports drinks. This study will be the first because of the domestic alternative sports drink research.

## **Materials and Methods**

### ***Study design***

Experimental and causal-comparison method, which is among the quantitative research methods, was used in this study.

### ***Sampling***

Natural mineral water was obtained from the source located 8.7 km away from the central town of Ağrı. The water sample was stored in an unused glass container at +4 °C. Samples were taken two times at 6 intervals and then were taken for analysis in Ağrı Ibrahim Cecen University's Central Research and Application Laboratory using the Na, Mg, K, Ca, Fe, Zn EPA 6020 method

## Analysis of Data

Mineral determinations of the local mineral water were made using Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) instruments. The ICP-MS device is an advanced technology device that allows rapid, precise and accurate, qualitative, quantitative or semi-quantitative measurement of many elements in solid and liquid samples (Thomas, 2008). The tests were repeated 3 times and the average values were written down. Measured values were evaluated with SPSS 25.0 Windows software (SPSS Inc., Chicago, IL, USA). Descriptive statistics (standard deviation, min., max. value) were used in the evaluation of the data. For the determination of Na, Ca, K and Mg elements, 100-fold dilution was applied and no dilution was performed for Fe and Zn elements. The results were evaluated according to the criteria specified in the United States Environmental Protection Agency (EPA) and the World Health Organization (WHO) and assessed retrospectively (EPA, 2022; WHO, 2017).

## Results

As a result of the analysis, the average sodium (Na) value in the local mineral water was found to be 26.6 ppm. Magnesium (Mg), which is one of the important minerals in sports nutrition, was determined as 7.78 ppm in local mineral water. Potassium (K) mineral was not detected in Agri local mineral water. Calcium (Ca), which is important for bone mineralization, was present as 65.04 ppm on average. Iron (Fe), which is one of the minerals that may be lacking in strenuous competitions, was identified as 0.0068 ppm on average. In addition, the antioxidant zinc (Zn) mineral was found as 0.02457 ppm on average (Table 1).

Table 1  
Agri Natural Mineral Water Mineral Values

Minerals	Agri Natural Mineral Water				EPA-WHO
	Average (ppm)	Max. (ppm)	Min. (ppm)	$\sigma$ (ppm)	Ave. (ppm)
Na	26.5	26.76	26.21	0.22	100
Mg	7.78	7.89	7.68	0.08	125
K	N/A	N/A	N/A	N/A	-
Ca	65.04	65.11	63.01	0.95	-
Fe	$6.38 \times 10^{-3}$	$8.52 \times 10^{-3}$	0	3.47	300

In Table 1, values are displayed according to the criteria specified in the United States Environmental Protection Agency (EPA) and the World Health Organization (WHO).

Table 2  
Mineral Contents of a Number of Mineral Waters in Turkey

Mineral Water	Na (ppm)	Mg (ppm)	K (ppm)	Ca (ppm)
Mineral Water 1	770.4	9.17	15.12	40.8
Mineral Water 2	40.04	36.2	8.23	288.97
Mineral Water 3	756.3	3.4	96.3	53.8
Mineral Water 4	31.2	49.5	2.2	164
Mineral Water 5	332.13	60	22.79	153.3
Agri Mineral Water	26.5	7.78	N/A	65.04

In Table 2, the mineral contents of sports drinks and Agri natural mineral water available in the local market are presented.

Table 3  
Mineral Contents of a Number of Mineral Waters in Turkey

Sport Drink	Na (ppm)	Mg (ppm)	K (ppm)	Ca (ppm)	Fe (ppm)	Zn (ppm)
Sports Drink 1	280	x	120	x	x	x
Sports Drink 2	220	x	220	x	x	x
Sports Drink 3	100	x	120	x	x	x
Sports Drink 4	440	x	180	x	x	x
Sports Drink 5	200	x	180	x	x	x
Sports Drink 6	220	x	120	x	x	x
Sports Drink 7	188	x	280	x	x	x
Sports Drink 8	33.37	N/A	40.93	314	N/A	N/A
Sports Drink 9	963.10	N/A	314.20	26	N/A	N/A
Agri Natural Mineral Water	26.5	7.78	N/A	65.04	6.38x10 <sup>-3</sup>	24.57x10 <sup>-3</sup>

In Table 3, the mineral contents of sports drinks and Agri natural mineral water available in the local market are presented.

## Discussion

The current classification of mineral water is based on the predominant chemical elements that result in the biological and curative effects of mineral water: bicarbonate water (bicarbonate content more than 600 mg/l); sulfated water (sulfate content more than 200 mg/l); chlorinated water (chlorine content more than 200 mg/l); calcium water (calcium content more than 150 mg/l); magnesium water (magnesium content more than 50 mg/l); fluorescent water (fluoride content more

than 1 mg/l); ferrous water (divalent iron content more than 1 mg/l); sodium water (sodium content more than 200 mg/l); and low salt water (sodium content less than 20 mg/l) (Petraccia et al., 2006).

Exercise brings about several changes in body composition and can therefore increase the body's need for iron stores. When present in the body in low concentrations, iron plays a crucial role in metabolic processes as an enzyme activator, stabilizer, and functional component of proteins. However, it is possible to mention other outcomes of iron above trace amount. It could be argued that there is a rather narrow "concentration window" between essential and toxic levels for all trace elements, including iron. In cases where iron levels in the body are abnormal, energy production is interrupted and athlete performance is negatively affected (Wenger et al., 2019). In addition, exercise can cause iron loss in urine, feces, and sweat or through hemolysis (Kuwabara et al., 2022). In long-term vigorous exercises and heavy training, immune cell functions may be suppressed, and in cases where nutrition is insufficient, the situation may worsen in terms of health functions (Abbaspour et al., 2014; Zhang et al., 2017). Considering metabolic events such as sweat, urea, and feces that reduce iron levels in the body, it can be assumed that insufficient protein consumption in sports branches that require long and intense training may cause "athlete anemia" for athletes.

In this study, different from sports drinks, the mineral water was found to contain iron mineral (0.00638 ppm). The current recommended limit for iron in water is 0.3 mg/l (ppm). When compared with other mineral water analyses in the literature, it may be stated that the rate of iron found in our study is sufficient (Azrina et al., 2011; Cidu et al., 2011; Ong et al., 2007; Völker et al., 2010).

Sodium is the most depleted mineral of the body when someone is sweating. Especially, long-distance runners may experience acute problems (semi-fainting or seizures) as a result of the events in which their ordinary tap water consumption will be insufficient because they are exposed to long-term and intense exercise in environments where the temperature is very high. Even in small amounts, the presence of sodium in water will be beneficial for the reabsorption of water into the body, and it will support the rapid absorption of carbohydrates and the regulation of blood volume (Lindinger and Cairns, 2021). In the study of Lau and Luk on different types of mineral waters, sodium values were found at the level of 2.4-34.5 ppm in samples taken from Australia, Indonesia, and China. In that study, it was noticed that the local mineral water had a Na content of 26 ppm (Lau and Luk, 2002). It was observed that this value was less than other sports drinks sold in the market (Shirreffs, 2009).

Potassium, an intracellular element, plays a key role in the muscle activity of individuals (especially in the heart muscle). It serves a number of functions in intracellular acid-base balance, regulation of osmotic pressure in tissue fluid, and several metabolic mechanisms. Helping the increase of tissue cells and its diuretic function are among its other duties (Bushinsky and Monk, 1998). A

decrease in serum potassium leads to paralysis in striated muscles and deterioration in heart muscle (Lindinger and Cairns, 2021; Mente et al., 2021). In the study of Lau and Luk on mineral waters, K was not detected in the sample taken from Indonesia, similar to Agri natural mineral water (Lau and Luk, 2002). A decrease in the amount of K is observed in athletes after a long exercise and competition. In the study, K could not be identified in local Agri water.

Magnesium (Mg) is a multifunctional mineral involved in more than thirty enzymatic reactions that enable synapse formation and impulse transmission, muscle contraction, and energy production using ATP. It is clear that magnesium, which is removed from the body with sweating, has a great function in muscle contraction. Long-distance runners may notice this functionality when exposed to prolonged and intense exercise. Insufficient magnesium in the body can manifest itself with epilepsy-like characteristics during or after training (Jahnen-Dechent and Ketteler, 2012; Romani and Scarpa, 1992). In our study, it was seen that the magnesium content in local mineral water (7,782 ppm) is similar to sports drinks on the market (Gebhardt et al., 2008).

Calcium is the most abundant mineral in our body. It performs an active role in bone and tooth content, muscle contraction, neurocognitive transmission, and blood coagulation. When there is insufficient calcium in the body, warning bells begin to ring for many systems. As a result of calcium withdrawal from bones, bone softening and bone loss called osteoporosis are encountered. Calcium deficiency in female athletes can lead to amenorrhea and subsequent asymptomatic differences that cause changes in the genital system and bone metabolism, all of which results from intense training (Bushinsky and Monk, 1998; Sozen et al., 2017). In the study, it was determined that there is 65.04 ppm calcium content in the local mineral water. It can be stated that this amount is high compared to sports drinks on the market (Ostrowska et al., 2016).

The deficiency of zinc, which is the initiator and executive of the events in the body, causes various complex reflections in athletes (Skrypnik et al., 2019). Zinc deficiency generates a decrease in performance in endurance training. Since zinc is involved in the structure of enzymes involved in carbohydrate, protein and fat metabolism, it is an element that has a great role especially during exercise (Roozbeh et al., 2009). In addition to the short-term effects of light exercise on zinc metabolism, it has been observed that high-level continuous exercise may also affect zinc metabolism for long terms. Immunological pressure may escalate during prolonged high-intensity exercise (Chu et al., 2016; Skrypnik et al., 2019). In our study, it was seen that the zinc content (0.02457 ppm) in the local mineral water is similar to the sports drinks in the market (0.03 ±0.09) (Pitta da Costa et al., 2020).

There are 3 different types of sports drinks: hypotonic, isotonic and hypertonic (Rowlands et al., 2011). In the study, it was seen that local mineral water has lower values than hypertonic sports drinks in terms of mineral drinking values and contains values similar to hypotonic or isotonic sports drinks, which are more suitable for aerobic endurance sports.

## Conclusion

Agri natural mineral water has similar mineral content to sports drinks. In addition, thanks to the calcium and iron mineral value it contains, it will provide an easy, cheap and accessible option compared to sports drinks. It can be a natural alternative to sports drinks if potassium mineral and glucose is added to its content (K: ~40-300ppm and glucose: %3-8).

## Authors Contributions Conclusion

Design of the Research: İHÇ, DAY

Data Collection: İHÇ, MEA

Statistical Analysis: İHÇ, DAY, GD

Preparation of the Article: İHÇ, DAY, MEA, GD

## Conflict of Interest

All authors declare that the study was done in the absence of any conflict of interest

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*Established As Result of Cooperation Between The European Foundation for Osteoporosis And The National Osteoporosis Foundation of The USA*, 33(2), 497–498. <https://doi.org/10.1007/s00198-021-06272-z>

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