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Curative Water in Jordan: Therapeutic Agents, Tourism and Archaeology

Abstract

This study briefly summarizes the composition of some thermal mineralized waters in Jordan, which have been used for therapeutic purposes for the past few thousand years. Scientific knowledge about the curative properties of certain agents in thermal and mineralized waters worldwide suggest such waters in Jordan can be classified as having very high therapeutic potential to treat diversified ailments related to the locomotive system, skin diseases, blood circulation, and psoriasis, among others. The various curative agents of these waters indicate that Jordan, in addition to its touristic and archaeological sites, is qualified to become a therapeutic center attracting millions of tourists to both visit its different archaeological sites and to enjoy treatment in its spas.

Becoming a therapeutic center would require developing the therapeutic sites

according to international norms, since at present most of the sites are not internationally competitive in terms of medical services, standards, advertisements, and marketing. There are economic, managerial, social, and scientific obstacles to raising these standards in Jordan which should be addressed on a national level to make therapeutic tourism an additional support for the country's economy.

The target of this brief article is to shed light on the properties of the curative waters in Jordan and to put that knowledge at the disposal of all concerned persons and institutions to illustrate the diversity of the types of these sources, which at present are neither quantitatively nor qualitatively exploited according to their potential. It is hoped that this article will be of use for researchers, economists, investors, practicing therapists, and decision-makers to help in taking the necessary

measures to make use of these natural resources for the benefit of people on local, regional, and international levels. Because of the potential health benefits, developing these resources will be a humane act for the country and its people when these sites are properly developed, in addition to any economic returns.

Introduction

Jordan is generally a country with scarce water resources, but in spite of that it is blessed by the abundant presence of thermal and mineral waters distributed throughout its territories, especially along the Jordan Rift Valley (FIG. 1) (Salameh *et al.* 2018). Historically, these waters were used as therapeutic agents (knowledge gained by experience) for many diseases such as rheumatism, disturbances of blood circulation, as a tranquilizing agent, for sterility and gynecology, and respiratory system diseases (Wimmer 2019; Pliny the Elder; The Bible: Genesis 36, 24; Josephus, *Antiquitates Judaicae* 17.6; Josephus, *Bellum Judaicum* 1.657¹, wherein Herod the Great searched for a cure from rheumatism). Archaeological sites are also present near thermal springs in Jordan, bearing witness to the use of the thermal spring sites for human settlement and curative purposes over time. Examples include the remains of King Salmon's Residence in 'Afrā, Herodias in Zarqā' Mā'in, the remains of a seaport and buildings at Az Zārah, Pella near KHirbat Salāh, and at the Abū DHāblah thermal mineralized spring (FIGS. 2–4).

Investigations of the physical and chemical properties of the curative

waters and the geological conditions governing the discharge of such spring water should, when compared with other spring sources in the world, indicate their curative properties (Salameh and Rimawi 1997; Abu-Ajamieh *et al.* 1988; Sawarieh and Massarweh 1993; Salameh 1982; Abu Ajamieh 1980; Bender 1968: 230). This in turn illustrates the scientific, economic, and medical relevance of these curative sources, which is hoped to lead to their exploitation for the benefit of the local population and visitors from abroad.

The sites of curative waters in Jordan along the Rift Valley enjoy special climatic conditions with long, dry summers and cool, wet winters. Air oxygen concentrations increase as elevation decreases down towards the Dead Sea. In that same direction, stronger absorption of waves takes place before the radiation of the sun reaches the surface of the ground because the thickness of the atmospheric layer increases in that same direction and the radiation cannot penetrate it, especially UV waves (Doughty 2019; Salameh 2010).

Thermal-Mineralized Water Composition and Properties

The analyzed physical and chemical properties of the thermal mineralized springs (TABLE 1) have been compared with similar sources in the world to indicate their potential curative purposes (TABLE 2) and to illustrate the economic relevance of these sources when correctly exploited for therapeutic purposes and as spas (Cleartrip 2017; Wimmer 2019; Doughty 2019; Solimene 2018; Giampaoli and Romano 2014; Dramdahl 2012; Harari 2012; Fleming and Gutknecht 2010; Osborn 2009; Priska 2008; Bender *et al.* 2005; Behari *et al.* 1996).

¹Josephus, *Bellum Judaicum* 1.657; *AJ*17.171: "(Herod) went over Jordan, and made use of the hot waters of Callirrhoe, which run into the lake Asphaltitis, but are themselves sweet enough to be drunk."

Table 1. Composition and properties of the main thermal and mineralized waters in Jordan.

| AREA | ZARQĀ' MĀ'ĪN | | Az ZARQĀ' RIVER | SUWAYMAH | WĀDĪ AL 'Arab | AL HĪMMAH | 'Afrā |
|-------------------------------------|---------------|---------|-----------------|----------|---------------|-------------|-------|
| | Ash SHallālah | Al Amīr | Hammām | Hīsbān | N. Ash SHūnah | Al Maqla'ah | 'Afrā |
| EH-value | 15.8 | 18.9 | 22.8 | 19.4 | 12.3 | 11.45 | nm |
| Temp °C | 56.6 | 48.6 | 47.1 | 31.8 | 52.7 | 41.4 | 46.6 |
| pH-Value | 6.3 | 6.2 | 6.76 | 6.37 | 7.06 | 7.12 | 7.12 |
| EC μS/cm | 3051 | 3080 | 1473 | 4190 | 981 | 1336 | 563 |
| TDS mg/L | 2279 | 2346 | 1114 | 3840 | 863 | 1117 | 297 |
| Na ⁺ meq/L | 19.52 | 18.63 | 7.79 | 29.01 | 3.3 | 5.86 | 36.41 |
| K ⁺ meq/L | 1.11 | 1.32 | 0.61 | 2.42 | 0.12 | 0.43 | 2.16 |
| Mg ⁺² meq/L | 3.22 | 3.41 | 2.05 | 8.82 | 3.66 | 2.69 | 17.91 |
| Ca ⁺² meq/L | 7.23 | 7.82 | 4.93 | 11.84 | 4.07 | 6.24 | 47.18 |
| Cl ⁻ meq/L | 21.52 | 22.32 | 9.17 | 28.04 | 2.83 | 6.03 | 69.38 |
| NO ₃ ⁻ meq/L | 0.1 | 0.05 | 0.04 | 0.04 | 0.02 | 0.05 | 0 |
| SO ₄ ⁻² meq/L | 3.82 | 3.93 | 2.51 | 7.7 | 1.75 | 3.44 | 66.17 |
| HCO ₃ ⁻ meq/L | 4.8 | 4.82 | 3.12 | 13.1 | 6.37 | 5.53 | 133.1 |
| CO ₃ ⁻² mg/L | 215 | 224 | 50 | 416 | 59 | 79 | 102 |
| F ⁻ mg/L | 0.31 | 0.43 | 0.22 | 0.61 | 0.61 | 0.81 | 0.2 |
| Br ⁻ mg/L | 7.74 | 7.21 | 4.02 | 6.44 | 0.91 | 3.13 | 0.03 |
| I ⁻ mg/L | 0.11 | 0.08 | 0.08 | 0.14 | 0.5 | 0.1 | 0.005 |
| TC meq/L | 31.1 | 31.2 | 15.4 | nm | 11 | 15.2 | nm |
| Fe mg/L | 0.09 | 0.23 | 0.11 | 1.34 | 0.12 | 0.18 | 0.1 |
| Mn mg/L | 0.6 | 0.79 | 0.56 | 0.13 | 0.007 | 0.008 | 0.003 |
| Cd mg/L | 0.01 | 0.005 | 0.003 | 0.0006 | 0.0024 | 0.0027 | nm |
| Zn mg/L | 0.06 | 0.049 | 0.024 | 0.015 | 0.002 | 0.018 | 0.002 |
| Pb mg/L | 0.02 | 0.023 | 0.13 | 0.027 | 0.03 | 0.03 | 0.002 |
| Rn nCi/L | 4.1 | 20.6 | 25.5 | 15.8 | 10.2 | 31.5 | 19.4 |
| NH ₄ ⁺ mg/L | 0.9 | 1.14 | 0.56 | 4.21 | 1.15 | 2.62 | nm |
| H ₂ S mg/L | 0.2 | 0.16 | 0.04 | | 5.8 | 9.5 | 0.3 |

In addition to the physical and chemical characteristics of these thermal mineralized springs, their sites along the Jordan Rift Valley enjoy special climatic conditions with long, dry summers and cool, wet winters, higher oxygen content in the air, and lower ultraviolet radiation than anywhere worldwide (Doughty 2019; Kudish 2012; Harari 2012; Dramdahl 2012; Salameh 2010):

- Air pressure is around 5% higher than at sea level.

- Air oxygen concentrations increase from the high mountains towards the Dead Sea by around 10%.
- Solar radiation, especially UV waves, attenuates, disperses, and decreases by about 12% at the Dead Sea shore compared with the highlands.

All these characteristics add to the curative properties of the thermal mineralized water and the Dead Sea's unique composition. Developing these resources to meet advanced international

Table 2. Main spa sites in Jordan and their curative agents.

| SITE | TEMPERATURE | RADON | IRON | BROMIDE | CO ₂ -GAS | H ₂ S-GAS | ASSEMBLAGE OF SALT & ION COMPOSITION |
|------------------------|-------------|-------|------|---------|----------------------|----------------------|--------------------------------------|
| Zarqā' Mā'in | Yes | Yes | No | Yes | Partly | Partly | Yes |
| Az Zārah | Yes | Yes | No | Yes | Partly | Partly | No |
| Al Himmah | Yes | Yes | No | Yes | Yes | Yes | No |
| North Ash SHūnah | Yes | Yes | No | Yes | Yes | Yes | No |
| Ibn Hammād | Yes | Yes | Yes | No | Yes | Yes | No |
| 'Afrā | Yes | Yes | Yes | No | Yes | No | No |
| Al Hasā (Burbayṭah) | Yes | Yes | Yes | No | Yes | No | No |
| Dayr 'Allā | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Az Zarqā' River Jarash | Yes | Yes | Yes | Yes | Yes | No | Yes |
| Wayḍa'a | Partly | No | Yes | No | Yes | No | No |
| Waqqās/DHāblah | Yes | Yes | Yes | No | Yes | Yes | No |
| Hīsbān and Rimāh | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Al Azraq | Yes | Yes | No | Yes | Yes | No | No |
| Dead Sea | No | No | No | Yes | No | No | Yes |

curative spas standards could increase therapeutic tourism, improve the health of visitors, and enhance the economy by creating new job opportunities.

Thermal Water Potential Uses in Jordan

Thermal water can be used to heat buildings such as green houses and in fish production but the primary discussion here focuses on thermal water as a therapeutic agent (Osborn 2009; Priska 2008; Behari *et al.* 1996):

- Water containing hydrogen sulfide gas helps blood circulation and the nervous system.
- Gaseous water containing carbon dioxide can be used as a drinking source and as an agent for enhancing blood circulation. It is used to cure disturbances in central blood circulation and in the limbs.
- Bromide-rich water can be used as a tranquilizing agent and helps relaxation.
- Radioactive water can be used for enhancing the functioning of all body parts, for numerous rheumatic diseases, and in certain cases of sterility and gynecology. This type of water should only be used externally.
- Iodide water can be used for drinking, and at a concentration which allows them to be classified as iodide waters can be used to enhance blood circulation, for respiratory tract inflammations, heart diseases, and eye diseases.
- Iron-containing water can be drunk and used to assist in cases of stomach, kidney, and intestinal suffering, enhancing blood circulation, and in the digestion process.
- Sodium-chloride-sulfate water has internal and external uses and is

used to treat diseases of stomach, kidney, intestines, and the nervous system. It is also used for rheumatic diseases.

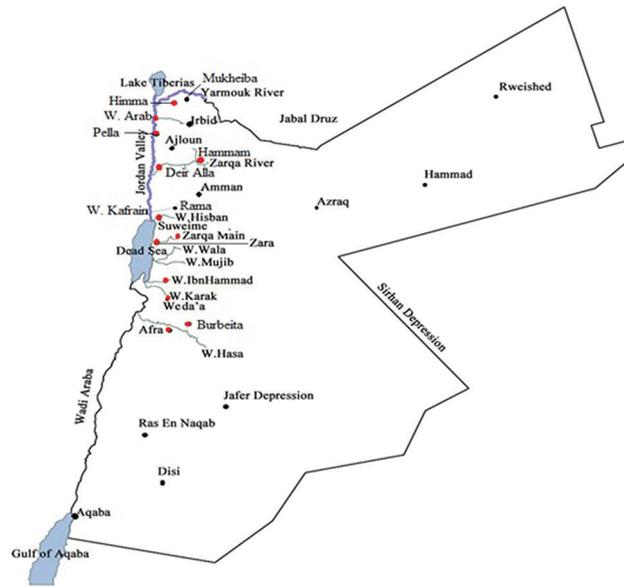
- Calcium-magnesium-sulfate water can be inhaled and used externally. It is used to treat rheumatism, the nervous system, the heart and blood vessels, and respiratory system diseases.
- Sodium-chloride water can be inhaled or used externally. It is used to treat respiratory organs in general and the respiratory tract in particular, the nervous system, rheumatism and gynecological diseases.

There are around 200 thermal springs in Jordan concentrated along the eastern side of the Jordan Rift Valley in the Zarqā' Mā'in, Az Zārah, 'Afrā, Waydaā, North Ash SHūnah and Al Himmah areas. FIGS. 5–8 show some photographs of such thermal springs and spa facilities. The composition of the water in these springs differs from one area to another, and accordingly so do their therapeutic agents, such as heat, H₂S, radon, iron, iodide, bromide, calcium, magnesium, sulfate, sodium, and combinations of these therapeutic agents (TABLES 1 and 2).

Conclusion

The therapeutic effects attributed to the different waters coincide with the therapeutic properties expected based on their chemical and physical properties. This shows that the centuries-long experience in this field from all over the world can be used to define the medical potentialities of Jordanian therapeutic water. In addition to its moderate climate, Jordan enjoys many other curative resources such as the above-mentioned thermal springs, the Dead Sea waters, and the special radiation and climate of the Al 'Aqabah area.

The above results indicate that Jordan, in addition to its moderate climate and pure clean air enjoys the presence of thermal springs with very high curative characteristics. These natural resources have up to now not been adequately exploited for health, recreation, or as a source of foreign currency income, which could help alleviate poverty by creating job opportunities for the population. It is recommended here to develop these natural resources and utilize them for therapeutic purposes to serve the local, regional, and international communities.



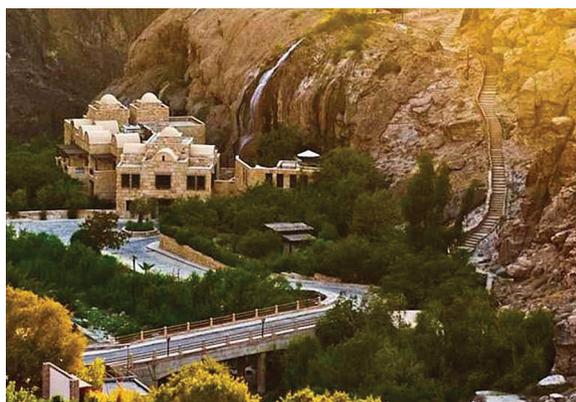
1. Map of Jordan with the main cities and sites of thermal mineralized springs: Zarqā Māʿīn, Az Zārah, North Ash SHūnah, Al Himmah, Waqqās, Abū DHāblah and Al Manshiyyah, Az Zarqā, Al Hammām, Dayr ʿAllā, ʿAfrā, Burbayṭah, Waydaā, Ibn Hammād, and the Dead Sea (image by the author).



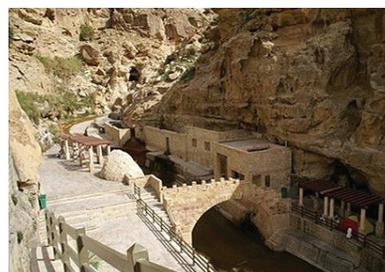
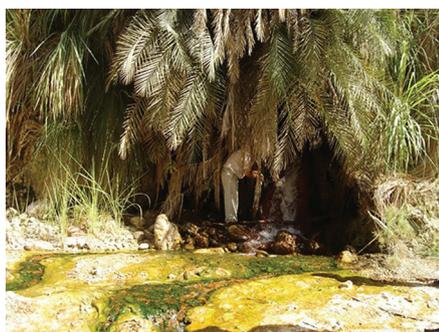
2. Ancient excavated resting place for cure seekers in the ʿAfrā area, around 50m above the ʿAfrā springs, with most probably drawings on the ceiling (photo by the author).
3. Remains of the Herodias port on the shore of the Dead Sea, with Az Zārah thermal mineralized springs close by (photos by the author).



4. The ruin of Pella with the columns to the left of the trees and the thermal spring of Abū DHāblah (not visible) along the nearby wadi further west to the left (photo by the author).



5. Zarqā' Mā'in thermal mineralized waterfall (photo by the author). 6. Amīr Spring in the Zarqā' Mā'in spa (photo by the author).



7. Afrā spa, a tributary of Wādī Al Hasā (photo by the author). 8. Sulfur spring in Wādī Udluft in the area of Az Zārah - Al Mūjib (photo by the author).

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