

Dermatological potential of thermo-mineral waters from Beira Interior Region, Portugal

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Abstract

Hydrothermal features in Portugal have been used since ancient times for therapeutic purposes that are mainly distributed in north and central region, being Beira Interior, located in central region, is characterized by eight spas. As for Portuguese thermo-mineral waters there are scarce studies about the characterization of its relation with the beneficial effects on human health. In last decade there is a renewing interest about thermalism and innovation, mainly on the evidence practice based in this area.

One of the most important factors that support the therapeutic effect of mineral medicinal waters is the physico-chemical composition. A physico-chemical categorization of these eight thermal waters was carried out in order to undertake an statistical analysis of the correlation of the physico-chemical classification and its therapeutic indication. According to this, data from these eight thermal waters were collected and submitted to Principal Component Analysis (PCA) and partial least squared (PLS) that clustered the selected thermal waters in 4 groups, regarding to their chemical composition, and correlated with the therapeutic indication.

1 Introduction

Portugal is one of the richest European countries in terms of thermal waters [1], where thermal spa treatment comprises the use of natural mineral water and other complementary means in therapy, rehabilitation and prevention of a number of diseases as well as in the promotion of well-being (Decreto-Lei n°142/2004). The use of these waters for therapeutic purposes, also known as mineral-

medicinal water, is based on the physico-chemical composition of these waters. Most Portuguese thermal waters are described as weakly mineralized, sulphurous, bicarbonate or chlorinate and sodium-type waters, and are mainly distributed in northern and central region. In the region of the Beira Interior of Portugal, eight thermal spas offer distinct therapeutic indications approved by the national health authority (Direção Geral da Saúde), but were not totally characterized [2].

2 Material and methods

A physico-chemical categorization of these eight thermal waters was carried out in order to undertake an analysis of the correlation of the physico-chemical classification and the therapeutic indication.

The role of dominant components in those waters was carefully assessed and putative correlations to specific therapeutic orientations were investigated by multivariate analysis. Principal Component Analysis (PCA) [3] and Clusters Analysis [4] were performed in order to evaluate the similitudes and differences between the physico-chemical composition as previously described for monitoring of water properties and interpretation of hydrogeochemical data [5] and then submitted to cluster analysis.

3 Results and Discussion

Our analysis highlighted that some of the studied waters have compositional and physico-chemical properties that partially explain their therapeutic qualities for dermatological applications, such as in the Termas do Cró and Monfortinho Spa.

Monfortinho thermal water is an oligomineral water whose main components are bicarbonate, sodium and silica, which together represent more than 50% of their total mineralization and confer the potential for dermatologic effect. The Cró thermal water is a medium mineral water, containing several mineral salts that give this water its peculiar chemical composition. Analysing the physico-chemical composition of these thermal waters in detail, a relationship between its composition and the dermatological therapeutic effect can be established since they are sulphurous waters, rich in silica and in certain cations with important functions for the skin (K^+ , Na^+ and Ca^{2+}) (Figure 1).

Table 1 describes some effects of the chemical elements present in thermal waters, namely sulfur, silica, sodium, calcium and potassium, on the skin.

Table 1. Effects on the skin of some chemical elements present in thermal waters (adapted from [6]).

Chemical element	Skin effects
Sulfur	Cellular regenerator. Keratoplastic or keratolytic (depending on the dose). Antioxidant. Antibacterial. Antifungal.
Silica	Involved in the synthesis of collagen and elastin. Participates in cellular metabolism. Abrasive in psoriatic plaques. Emollient effect.
Sodium	Participates in the fluid balance of tissues.
Calcium	Regulates cell division, acting on the calmodulin and on the binding protein of retinoic acid. Catalyzes the activity of enzymes of differentiation: transglutaminase, phospholipase and protease. Regulates the permeability of cell membranes. Regulates the proliferation and differentiation of keratinocytes.
Potassium	Involved in the synthesis of nucleic acids and proteins. Participates in cellular energy production.

Results from PCA, in compliance with cluster analysis shows that the dermatologic therapeutic indications invoked by the presence of sulfur, silica

and different cations, such as sodium, calcium and potassium are partially justified. Also, from this analysis, is highlighted that thermal waters of the Beira Interior region of Portugal have its own physico-chemical behavior, which significantly influences the therapeutic vocations attributed to them.

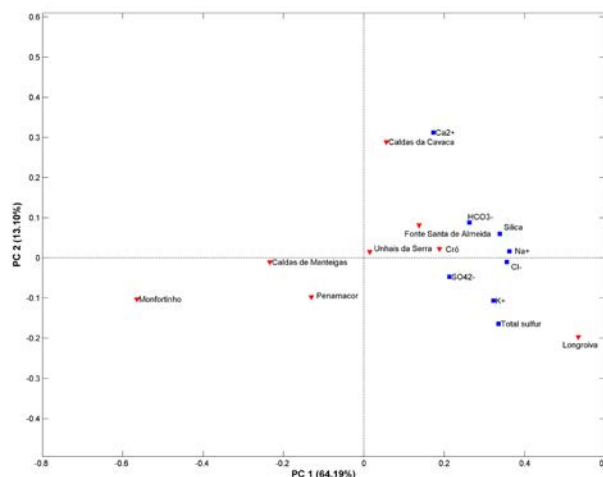


Fig. 1. Biplot of the first two components of the PCA made with 8 variables in absolute value

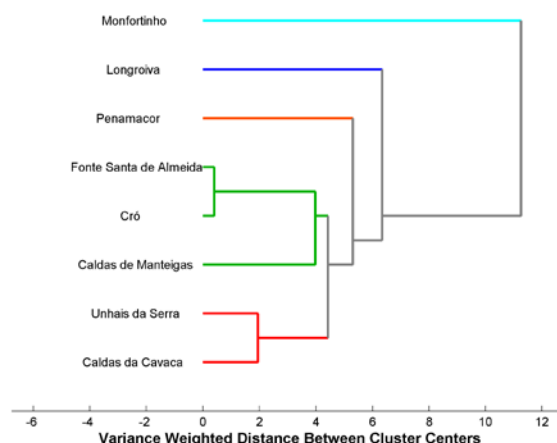


Fig 2. Dendrogram of the Ward's method for cluster analysis when using all the variables in absolute value

4 Conclusion

In conclusion, the performed data analysis demonstrated to be an effective tool in the identification of the main structural interrelationships among the physico-chemical parameters of thermal waters, enhancing their similarities and dissimilarities. The achieved categorization of the thermal of the Beira Interior region of Portugal could be used as a useful approach of therapeutic armamentarium to direct for well and specific-oriented pathological disturbs, besides the promotion of well-being associated to the thermalism.

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References

- [1] APRH, A. P. d. R. H. (2014). A água subterrânea.
- [2] Araújo, A.R.T.S., Paiva, T., Ribeiro, M.P., Coutinho, P. Innovation in Thermalism: An Example in Beira Interior Region of Portugal, Chapter 11 in Health and Wellness Tourism: Emergence of a New Market Segment, Marta Peris-Ortiz and José Álvarez-García (editors), Springer, 2015;165-180.
- [3] Jolliffe, I. T. (2002). Principal component analysis and factor analysis. *Principal component analysis*, 150-166.
- [4] Naes, T., Isaksson, T., Fearn, T., & Davies, T. (2002). A user friendly guide to multivariate calibration and classification: NIR publications.
- [5] Rebelo, M., da Silva, E. F., & Rocha, F. (2015). Characterization of Portuguese thermo-mineral waters to be applied in peloids maturation. *Environmental Earth Sciences*, 73(6), 2843-2862.
- [6] Faílde, R. M., & Mosqueira, L. M. (2006). Afecciones dermatológicas y cosmética dermo-termal. *TÉCNICAS Y TECNOLOGÍAS EN HIDROLOGÍA MÉDICA E HIDROTERAPIA*, 175-179.