Thermal spring waters: From balneotherapy to genomics

Águas termais: da balneoterapia à genômica

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ABSTRACT

This review article reports the scientific data available on La Roche-Posay thermal water and clarifies its mechanisms of action, indications, and clinical benefits. Clinical studies and genomic evaluation of the skin microbiome have shown that La Roche-Posay thermal water improves the skin microbiome's diversity and reduces the severity of skin lesions in inflammatory dermatoses, such as atopic dermatitis and psoriasis. Therefore, it justifies the use of selenium-rich water in topical formulations to prevent or treat skin diseases and as an adjunct to increase dermatological patients' quality of life.

Keywords: *Balneology; Cosmetics; Mineral Waters; Selenium; Skin; Thermal Water*

RESUMO

O presente artigo de revisão relata os dados científicos disponíveis sobre a água termal *La Roche-Posay* e esclarece seus mecanismos de ação, suas indicações e seus benefícios clínicos. Além disso, estudos clínicos e avaliação genômica do microbioma da pele demonstraram que esta água termal melhora a diversidade do microbioma da pele e reduz a gravidade das lesões cutâneas em dermatoses inflamatórias, tais como dermatite atópica e psoríase. Justifica-se, portanto, o uso de água rica em selênio em formulações tópicas na prevenção ou tratamento de doenças de pele e como coadjuvante para aumentar a qualidade de vida dos pacientes dermatológicos.

Palavras-chave: Águas Minerais; Águas Termais; Balneologia; Cosméticos; Pele; Selênio

INTRODUCTION

In ancient times, when therapeutic options were more limited than today, hot springs (or thermal waters) to treat different physiological conditions were very popular.[1] The beginning of the European balneotherapy development occurred in the Greek hydromineral sources. The Greek physician Hippocrates (460 - around 375 BC) began to use hydrotherapies and balneotherapies to treat specific clinical conditions. As an analytical researcher, he highlighted the differences between the therapeutic indications from the various micro-sources minerals, theorizing that the different healing properties were related to different mineral contents.[2] Greek civilization extended to areas conquered by the Romans, who preserved the balneotherapy culture, developing new techniques and building public spas.

Since the 3rd century BC, doctors have attributed therapeutic value to mineral sources. Thermalism had central impor-

Review

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tance in the life of Romans. It was affected by the disintegration of the Roman Empire and the consequent fall of the Greco-Roman culture, but it left a strong influence on European civilization.[2]

Historically, mineral waters are also important as therapeutic agents within the pharmacy. The world's first pharmacopeias, such as Genevensis in 1780, Borussica in 1799, Galica in 1818, Helvetica in 1933, among others, prescribed natural mineral water as an effective bioactive agent in external and internal applications to treat diseases.[2,3]

In the 19th century, interest in balneotherapy or thermalism grew in North America and Europe. Even nowadays, countless health resorts with specific thermal waters carry on this tradition.[4] In the last three decades, despite limited literature with clinical evidence, there has been a resurgence of interest in balneotherapy, with support from the medical community to alternative or complementary therapies.[5]

In Brazil, thermalism and crenotherapy, that is, the set of therapeutic practices that uses mineral waters with medicinal properties, in a preventive or curative way, once again received attention from the Ministry of Health after approval of the National Policy on Integrative and Complementary Practices (Política Nacional de Práticas Integrativas e Complementares - PNPIC) in 2006 to users of the Public Healthcare (Sistema Único de Saúde - SUS).[6,7]

Hot springs or mineral water sources with therapeutic properties[8] have been mentioned for benefiting from rheumatic and musculoskeletal disorders to a variety of diseases in Dermatology, Pulmonology, Hematology, and Gastroenterology.[9,10] Regardless of having started empirically, the hot springs therapeutic use has an important investment in research currently to understand its mechanism of action and clinical benefits offered to patients.[11] Although it is still difficult to attribute the measured effects to specific parameters, there is evidence that the different mineral and microbiological compositions of thermal waters and their consequent physical, chemical, and biological properties impact the physiology of skin cells.[1,12,13]

HOT SPRINGS AND DERMATOLOGY

Mineral waters, both thermal and non-thermal, are aqueous solutions containing minerals and trace elements formed under specific geological conditions that present a physical-chemical dynamism. They naturally appear in sources or springs and are free of pathogenic microorganisms, thus having therapeutic potential.[14,15]

For centuries, mineral water has been known to treat inflammatory dermatological diseases, mainly psoriasis and atopic dermatitis.[1,16] The observed clinical efficacy may be related to the penetration of some water-soluble minerals into human skin. Minerals such as selenium, magnesium, sulfur, calcium, and zinc are directly related to the skin structure.[9]

Thus, parameters such as purity, pH, soluble minerals content, and the presence of trace elements should be contemplated in the selection of waters for dermatological therapy. The variety of thermal springs, different from each other in their hydrogeological origin, chemical composition, and physical properties, should also be considered.[15]

Although there are no waters with the same chemical composition, they can be grouped based on the dissolved mineral salts content, quantified by the total mineralization present in mineral waters (dry residue determined at 180 °C). They are classified as oligomineral water (mineralization less than 200 mg/L); medium mineral waters (mineralization between 200 mg/L and 1000 mg/L); and mineral waters (mineralization above 1000 mg/L).[17] Depending on the nature of the geological material traversed by groundwater, they can also be classified by the predominant mineral element in their compositions.[18] Internationally, thermal springs are, in general, classified into five main categories: bicarbonate, sulfate, sulfide, chloride, and weakly mineralized trace elements.[11]

The mineral content of thermal waters interferes with its sensory properties and the comfort provided to the skin. The magnitude of softness and the skin's smoothness and comfort are higher when the thermal waters have lower concentrations of mineral salts (<1000 mg/L).[19] These properties are essential for patients with chronic dermatoses frequently associated with skin dryness and itching.[11] In general, thermal waters have no adverse events and rarely induce inflammatory reactions. Therefore, they can be used safely in all skin conditions characterized by extreme sensitivity and cosmetic intolerance.[17] Thus, there is a real interest in thermal waters for dermatological and cosmetic purposes, amplified by other possible attributes, particularly the anti-inflammatory, antipruritic, and antioxidant properties of these mineral waters.[11,17,20]

Especially in recent decades, the French industry commercialized thermal waters as cosmeceuticals or dermocosmetics,[20] requiring efforts to scientifically prove their effects, where the use of cell cultures has been helpful.[1,21] The regulation of immunological parameters through supplemented means was observed in mast cells,[22] Langerhans cells,[21] and CD4+ T lymphocytes.[23,24] A recent study used keratinocyte cultures (HaCaT) to determine the effects of four types of hypotonic mineral waters. The study assessed two French thermal water and two drinking mineral water, comparing them to control. The research investigated the DNA proliferation regarding cytotoxicity, interleukin-6 (IL-6) expression, and reactive oxygen species (ROS) formation after stimulation with ultraviolet B (UVB). The results indicated that both thermal waters significantly reduced basic parameters, such as proliferation and cytotoxicity, and decreased the IL-6 levels in the medium after UVB irradiation to levels similar to those observed with betamethasone 17-valerate, a reference anti-inflammatory (positive control). Also, there was a significant reduction in ROS levels regarding the control non-irradiated with UVB.

This effect was attributed to the trace elements contained in mineral waters. Paradoxically, both drinking mineral waters also had some effect on the mentioned parameters, but to a lesser extent.[1]

The French thermal waters used by Zoller *et al.* (2015) are commercially available in pharmacies in Brazil[20] and have a

mineral content <1000 mg/L. The anti-oxidant activities observed were attributed to the high selenium content and/or the zinc in the composition of the thermal waters.[1] Thus, the results of this article highlight the importance of trace elements, such as selenium and zinc, and provide scientific justification for the application of thermal waters in treating chronic inflammatory skin diseases.[1]

THERMAL WATERS AS COSMECEUTICALS

The scientific data currently available on thermal waters provide a better understanding of these waters' biological mechanism of action concerning their composition, physic--chemical properties, and clinical benefits. It justifies the interest in using them as an active ingredient or "cosmeceutical" in topical formulations that seek to increase the quality of life and adherence to dermatological treatments.[11] A critical focus in developing cosmeceuticals/ dermocosmetics is to maintain the balance of the skin's microbiota. In general, thermal waters can modify the composition and activity of the skin microbiome due to their physical and chemical properties. It has already been demonstrated that they have their own set of thermophilic microorganisms.[13]

Formulations properly developed with thermal waters can increase the activity of microorganisms beneficial to the skin, prevent cutaneous dysbiosis, restore the skin's barrier function, and have an anti-irritating, anti-inflammatory, and antioxidant action. These formulas containing thermal water as an ingredient are essential for skin conditions that present barrier dysfunction, such as dryness, sensitivity, skin reactivity; exposure to aggressive cosmetic or hygiene routines; after aesthetic procedures; during or after the use of corticosteroids.[11,16,17,42] However, it is noteworthy that there are different thermal water compositions, which should be considered when choosing this ingredient and assessing the formulations.[11,17,20]

LA ROCHE-POSAY THERMAL SPRING WATER

Mineral composition and biological properties

The concentration of minerals and non-pathogenic microorganisms in La Roche-Posay thermal spring water (LRP-TSW) may explain its therapeutic benefits in inflammatory skin diseases, improving skin conditions in atopic dermatitis, psoriasis, and skin dryness.[10]

LRP-TSW has a unique mineral composition, characterized by an exceptional balance of minerals and trace elements. It is classified as medium mineral water (mineralization: 595 mg/L), presenting a neutral pH and providing comfort to the skin.[11]

It contains adequate minerals levels with dermatological effects, such as bicarbonate and calcium, which are essential for skin renewal; silicate, which helps to reduce skin irritation, mainly improving the skin softness and flexibility; and a set of trace minerals naturally rich in selenium, in addition to copper and zinc, which are cofactors of the enzyme superoxide dismutase (Cu-Zn-SOD), an important antioxidant defense of skin cells.[11,32] Selenium, an essential element for human cells' normal and protective metabolism, maintains cell integrity and neutralizes free radicals and organic peroxides. The protective effect of this mineral relates to its presence in the active center of the enzymes glutathione peroxidase (GSH-Px) and thioredoxin reductase (TRX-Rs), which protect DNA and other cellular components from oxidative damage.[11,32,33] It occurs because the selenium in GSH-Px can control the intracellular levels of hydrogen peroxide, affecting the reactive oxygen species formation, which can serve as lipid peroxidation initiators. This selenium role is closely related to superoxide dismutases, which control the intracellular levels of the superoxide anion, being an important antioxidant defense.[49] Selenium also plays a prominent role in regulating excessive immune responses and chronic inflammation. Its deficiency is known to impact negatively the processes of activation, differentiation, and proliferation of immune system cells, also related to the increase in oxidative stress.[50] In addition, the effect of selenium against photoaging due to its antioxidant properties has been demonstrated.[20]

Fibroblast culture studies have shown that the addition of selenium or LRP-TSW to the medium can induce a protective effect on fibroblasts exposed to UVA, as there was an increase in their survival percentage by a multiplication factor of 1.6 and 1.8, respectively. Concomitantly with the increased survival of these cells, there was a decrease in UVA-induced lipid peroxidation, both in the presence of selenium (-46%) and selenium-rich thermal water (LRP-TSW) (-42%), probably due to the activity of GSH-Px.[32,34,35] Furthermore, keratinocytes cultured in a medium containing LRP-TSW have better resistance to increased UVB doses, demonstrated by protection against cytotoxic effects using the neutral red incorporation method. Also, UVB rays can induce inflammatory reactions that release mediators that can be monitored both in vitro and in vivo, including interleukin-1a (IL-1a). A study demonstrated that keratinocytes in the presence of LRP-TSW after UVB irradiation significantly reduced the release of this inflammatory mediator.[34,35] Selenium-rich thermal water (LRP-TSW) also had a protective effect against chemically induced irritant contact dermatitis. Sodium lauryl sulfate, a known irritant, induced an inflammatory reaction that was decreased by 46% in subjects previously treated with a gel formulated with LRP-TSW compared to only 15% reduction seen in individuals who used demineralized water gel.[34,35]

The effect of selenium on lipid peroxidation has also been studied in human skin fibroblast cultures. Immediately after exposure to ultraviolet A radiation (365 nm, 18J/cm^2), a decrease in lipoperoxides in the cell culture supernatant was observed by quantifying substances reactive to thiobarbituric acid - an indicator of lipid peroxidation. Antioxidant defenses, including the level of total glutathione (GSH) and activities of superoxide dismutase (SOD), glutathione peroxidase (GSH-Px), and catalase, were simultaneously verified before and after irradiation. The results demonstrated that the sensitivity of human fibroblasts to UVA-induced lipid peroxidation depends on a balance between the activities of SOD and catalase.[36] A reduction factor of 1.8 and 1.7 times, respectively, was observed in cells cultured in a medium supplemented with selenium or LRP-TSW compared

to a control medium containing demineralized water. In parallel, selenium-GSH-Px activity and cell viability were significantly increased.[36,37]

In vitro studies have proven the LRP-TSW immunomodulatory and anti-inflammatory properties by assessing Langerhans cells' migratory and stimulating capacities in the human epidermis. The migration of Langerhans cells sensitized by trinitrobenzene sulfonic acid (TNBS) was inhibited in a culture medium reconstituted with LRP-TSW compared to a medium containing demineralized water. LRP-TSW also reduced the expression of human leukocyte antigen (HLA-DR) molecules by 25%. HLA-DR is a monocyte and macrophage receptor of the histocompatibility complex class II (MHC II). Reduced expression of HLA-DR means less production of pro-inflammatory cytokines. Other costimulatory molecules expressed on the surface of the Langerhans cell also had their expression reduced, such as B7-2 (CD86; 35%) and ICAM-1 (25%), compared to the control medium, increasing the anti-inflammatory activity.[11,21,38] Also, the modulating effects were evaluated in media containing selenium salts, strontium, or LRP-TSW, using models of skin reconstructed after healthy skin biopsies and skin with atopic dermatitis (inflammatory model). There was a lower production of inflammatory cutaneous cytokines (IL-1a, IL-6, and tumor necrosis factor-alpha [TNF-α]) in the reconstructed skins than the control medium in all evaluated media. LRP-TSW, rich in selenium and strontium, induced a moderate inhibitory effect on the production of inflammatory cytokines, particularly IL-6.[38,39]

A randomized, double-blind study analyzed the protective effect of LRP-TSW against skin lesions induced by UVB. The research investigated ten individuals with skin phototypes II and III, comparing a cream containing LRP-TSW to another containing demineralized water. The creams were assessed regarding their ability to protect the skin against the formation of erythema induced by UVB (colorimetric evaluation) and sunburn cells (biopsy). Neither the LRP-TSW nor the control cream provided significant protection against erythema. However, there was a substantial reduction in the number of sunburn cells in the epidermis in the areas pretreated with the cream containing selenium-rich thermal water compared to the cream containing demineralized water.[40]

Microbial composition and biological properties

From a microscopic perspective, the skin is a complex environment inhabited by trillions of different microorganisms comprising the skin microbiome.[25,26] The intense diversity and composition of the microbial communities vary according to the skin region and between individuals.[10] The skin microbiota comprises about 80% gram-positive and 20% gram-negative bacteria, with bacterial diversity driven mainly by gram-negative bacteria and abundance by gram-positive bacteria.[10] Interesting findings suggest that the skin microbiome may influence infections, inflammatory diseases and skin immunity.[13,27] It may also protect the skin from pathogenic bacteria in different ways, including bacteriocins production, adhesion, and bacterial nutrients competition, toxins degradation, increased antibody production, and modulation of cytokine production.[27] Numerous inflammatory skin diseases are associated with loss of diversity in the skin's microbiota. Rosacea, acne, sensitive skin, and seborrheic dermatitis can be mentioned in addition to psoriasis and atopic dermatitis.[10,42]

When evaluating the microbial composition of the LRP-TSW through metagenomics, a global bacterial picture containing low concentrations of bacteria was observed. There was a high bacterial diversity and a greater proportion of gram-negative than gram-positive bacteria. The dominant phyla were Proteobacteria and Bacteroidetes, both of gram-negative bacteria.10

The lysis of a gram-negative, non-pathogenic, aerobic bacterium of the phylum Proteobacteria - Vitreoscilla filiformis - has been used as an ingredient in the formulation of cosmetic preparations.[10,28] A continuous technological process has been developed to produce a V. filiformis biomass (VFB) that has been shown to improve skin defense mechanisms. This bacterium contains lipopolysaccharide (LPS) that, once isolated, reproduces BVF activity. This biomass is well recognized by Toll-like receptors-2 (TLR2), inducing defensin expression and stimulating the protein kinase C zeta (PKCz) pathway and the mitochondrial antioxidant defense system. It leads to a homeostatic defense reaction and provides a protective biological shield, reinforcing skin resistance.[28,29]

When adding LRP-TSW to the V. filiformis culture medium, the obtained biomass (LRP-VFB) activated mitochondrial superoxide dismutase and showed an even better ability to stimulate innate skin defense biomarkers.[29]

The use of cosmeceuticals developed with the lysis of V. filiformis promotes a significant improvement for patients with inflammatory skin diseases.[30,31,41]

As LRP-TSW contains live bacteria that affect the skin microbiota, the thermal spring water (balneotherapy) acts as a probiotic. There are many questions about the applicability of a probiotic, since for these microorganisms to remain alive, they need to resist manipulation, temperature, storage, and transport.[11,42]

While a probiotic is a product containing live microorganisms, a prebiotic product contains an ingredient that selectively stimulates or inhibits the growth or activity of skin commensal bacteria.[42] Filtered LRP-TSW, which does not contain live bacteria, can be considered a prebiotic used in dermocosmetics. The prebiotic LRP-TSW has shown to be beneficial in individuals with healthy but dry skin. Corneometry assessed the effect of LRP-TSW used in a commercially available spray (two sprays per application, twice a day, for 14 days, on the inner part of the forearm) in 70 healthy individuals with dry skin. Thirty minutes after the last application, the microbiota in the treated region and a nearby untreated area was evaluated. The treatment resulted in a significant increase in gram-negative bacteria and a decrease in gram-positive bacteria on the skin surface of treated areas versus nearby untreated areas, increasing bacterial diversity and the resilience of treated regions.[10,42] In a similar protocol, the topical application of a moisturizer containing high concen-

trations of LRP-TSW demonstrated a significantly high level of bacteria of the genus Xanthomonas that can be correlated with the increased skin hydration levels.[10]

Clinical studies have indicated that balneotherapy using LRP-TSW (probiotic) stimulates gram-negative bacteria on the skin surface, particularly from the Xanthomonadaceae family. Their main genus is Xanthomonas, improving the microbial diversity of the skin. The increase in bacteria of the genus Xanthomonas was associated with a decrease in the severity of inflammatory skin conditions and a reduction of bacteria of the genus Staphylococcus.[43] Without using an antibiotic, LRP-TSW can modify the microbiota in human skin.[10,31,44]

Therapeutic properties

Many therapeutic uses of LRP-TSW have been described in chronic inflammatory diseases, such as atopic dermatitis[10,15] and psoriasis.[10,43,45] However, it can also be helpful in skin healing[46] and other dermatoses, such as rosacea and ichthyosis.[47]

Healing

The LRP-TSW spray effectively treats scars after pediatric plastic surgery, demonstrating that it can reduce the inflammatory aspect of scars, easing the itching, facilitating the removal of the crusts, providing a careful cleaning after non-traumatic surgery. Finally, it helps prevent infection, common in these cases, due to excessive washing to remove debris.[46]

Atopic dermatitis

The effect of LRP-TSW on the microbiome of 31 patients with atopic dermatitis was evaluated after 21 days of balneotherapy. Microbial samples were collected from affected skin and non-affected adjacent skin.

At the beginning of the study, bacterial diversity was lower in the injured skin of atopic dermatitis compared to the adjacent clinically healthy skin. After balneotherapy, the diversity index increased in the injured areas and became similar to that observed in clinically healthy skin. In addition, balneotherapy resulted in a reduction of Firmicutes organisms, mainly of the Staphylococcus genus, and an increase in the quantity of the bacteria of the genus Xanthomonas. The increase in bacterial diversity after balneotherapy was correlated with significant growth of gram-negative bacteria and a significant reduction in gram-positive bacteria on the skin. Balneotherapy provides lasting results, with clinical and quality of life improvements sustained for an average of six months.[10]

Cosmeceuticals containing LRP-TSW also improve the diversity of the skin microbiome in patients with atopic dermatitis. A monocentric study assessed 49 patients with moderate atopic dermatitis after three months of application, twice a day, of an emollient containing high concentrations of LRP-TSW. The research showed that comparisons between the affected area and the adjacent unaffected skin in the same patient with atopic dermatitis provide good information about the bacterial communities involved in skin dysbiosis. The skin affected by atopic dermatitis hosts less diverse microbial communities than the unaffected skin. Also, the lesion microbiota was dominated by Staphylococcus species when compared to the microbiota of the adjacent uninjured skin. The clinical picture improved in 72% of patients with a concomitant increase in bacterial diversity and decreased Staphylococcus in the affected skin.[44]

Another comparative, double-blind, randomized study analyzed 60 patients with moderate atopic dermatitis. The individuals were randomly divided into two groups (A and B) and received the products for application twice a day, for 28 days: emollient A in lipophilic cream containing 20% shea butter, 4% niacinamide, LRP-TSW, mannose, and V. filiformis biomass grown in a medium containing LRP-TSW (LRP-VFB); or emollient B, a commercial product for atopic dermatitis containing triglycerides, glycerin, shea butter, and ceramide. Samples were collected in affected and adjacent non-affected areas before and after treatment to assess the bacterial community. The evaluated results associated the microbiota and the score to evaluate the severity of atopic dermatitis, called Scoring Atopic Dermatitis (SCORAD) of patients. After 28 days, the mean SCORAD of patients treated with emollient A was lower than those treated with emollient B, meaning remission or improvement of the condition. It is worth mentioning that the SCORAD associated with patients in crises was lower in the emollient A group (46%) versus the emollient B group (79%). A significant increase in the genus Xanthomonas bacteria was observed in the group treated with emollient A compared to emollient B.

On the other hand, the *Staphylococcus* genus bacteria increased between Days 1 and 28 in the emollient B group. However, in the emollient A group, it was not observed. This study demonstrated that a specific emollient containing LRP-VFB, which proved to be prebiotic, can normalize the skin microbiota and significantly reduce the severity of atopic dermatitis and acute manifestations, compared to the other emollient.[31]

Psoriasis

A clinical study subjected 92 individuals with moderate to severe plaque psoriasis to balneotherapy with LRP-TSW every day for three weeks. The subjects also ingested one liter per day of selenium-rich LRP-TSW. The evaluation parameters included clinical evaluation using the Psoriasis Area and Severity Index (PASI) and plasma levels of silicon. After three weeks, the PASI was reduced by 47±4%. In 8% of the individuals, the lesions disappeared completely, while in 48%, the lesions improved by more than 50%. At the end of balneotherapy, a significant increase in mean plasma selenium levels was observed, correlated with a reduction in PASI.[45]

Another study evaluated the skin microbiome in 27 patients with moderate to severe psoriasis before and after three weeks of balneotherapy with LRP-TSW. The research compared samples collected in an affected skin area and an unaffected adjacent region. The clinical evaluation showed a 61% reduction in PASI after balneotherapy (initial PASI: 21±10; PASI after balneotherapy: 8±5). Deficient bacterial biodiversity was noted in patients with psoriasis, and bacterial communities were similar in affected and non-affected adjacent areas. The average taxonomic

composition of skin bacterial communities associated with the unaffected and affected skin of psoriatic patients after balneotherapy showed a significant increase in bacteria of the genus Xanthomonas, known to be keratolytic and associated with the clinical improvement. To a lesser extent, there was an increase in the genus Corynebacterium bacteria, associated with a decrease in the genus *Staphylococcuss* bacteria.[43]

In 2012, 199 patients with severe plaque psoriasis (74.4%) or guttate psoriasis (12.1%) were treated with LRP-TSW (balneotherapy).

After treatment, the mean PASI scores were reduced by 57%; 96% of the patients showed some improvement in PASI value; and 78% showed improvement in the Dermatology Life Quality Index (DLQI). Those who had previously undergone balneotherapy with LRP-TSW previously reported a continuous improvement in quality of life for 7±3 months and sustained remission of psoriasis for an average of 6±3 months after treatment with LRP-TSW.[10]

FINAL CONSIDERATIONS

Thermal water has been used for many years in balneotherapy and also as aerosol or in topical formulations, presenting satisfactory results in Dermatology.

La Roche-Posay thermal spring water has demonstrated, in in vitro and in vivo studies, a protective action against the harmful effects of reactive oxygen species induced, for example, by ultraviolet light, in the short and long term. In addition to the antioxidant and immunomodulatory effects, it also proved its anti-inflammatory and anti-irritant potential, suggesting that its regular use can increase the quality of life of dermatological patients.

The unique mineral composition of LRP-TSW, containing bicarbonate, silicate and, mainly, high selenium concentrations (53 µg/L), is related to a large part of its benefits. More recently, because it contains live bacteria that affect the skin microbiota, it was considered to act as a probiotic when used at the source. Its microbial composition naturally presents a low concentration of bacteria (not pathogenic), with a high diversity and a higher proportion of gram-negative than gram-positive bacteria. The main phylum found in LRP-TSW was Proteobacteria.

The results justify the use of La Roche-Posay thermal spring water as a therapeutic option in inflammatory skin conditions, with barrier dysfunction and susceptibility to sensitivity and irritations, through available dermocosmetic forms, either in the pure form as an aerosol, either as an active ingredient in topical dermatological formulations, as emollients and sunscreens. ●

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