

# Health Applications of Naturally Aged Medicinal Mud

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The Copahue Thermal Complex is located in the northwest of the province of Neuquén, Argentina in the Ñorquín department. It lies near the Chilean border, 376 km from the capital of the province at 2,010 meters above sea level. The Copahue complex is located in a geothermally active area in a volcanic caldera, surrounded by multiple fumaroles, potholes, vents, springs and a series of mineromedicinal water lagoons. Copahue is a system of spring acid waters, hyperthermal and largely of high mineralization. The so-called "mother sulfur lagoon" consists of hyperthermal sulfated water, with a dry residue 110°C, 1075 mg / l; pH: 5.6 and chemical analysis shows the following mineral concentrations (mg / l): chlorine 2.7; fluoride 0.3; sulfate 586.3; sodium 29.3; potassium 19.1; lithium 0.02; calcium 44.6; magnesium 11.3; total iron 2.2; ammonium 54.8. The mother sulfur lagoon produces mud that is composed of: smectite (39%), kaolinite (6%), silica (6%), pyrite (2%), alunite (2%), iron oxides (4%), and a strong presence of sulfur at 39%. The contact water maintains an acid pH of the order of 2.5 to 3, and contains dissolved substances on the order of 700 to 1000 mg / l, while the temperature of the water and the mud of this lagoon is one of the highest among the natural manifestations of Copahue. Regarding the mud, it can be added that it is an excellent adsorbent, has an ion exchange capacity of the order of 10 meq / g, and a cooling kinetics that makes it an adequate material to achieve thermal effects associated with its application. This lagoon is the main producer of mud used in the cabins. In terms of medical applications, sulfur is a particularly important component, which as pure mineral has disinfectant, keratolytic and antiseptic properties, and can also be transformed to give rise to other minerals that contain sulfur (in forms reduced and oxidized) such as alunite and pyrite. At the same time, both kaolinite and smectite act as excellent adsorbents, dermal protectors and give softness to peloids, while improving their thermal properties. The microbiological richness that it possesses is also an

outstanding feature of this system. The prokaryotic biodiversity of the Sulfur Lagoon (LS T = 54° C and pH: 3) was studied using two complementary techniques: a) phylogenetic analysis of the 16S rRNA genes of bacteria and archaea; and b) in situ hybridization of specific fluorescent probes (FIHS) for a quantitative estimation of microbial biodiversity. The results obtained showed that in this thermal well 90% of the microorganisms are archaea, 6% are bacteria and 4% could not be detected by FIHS. Within the bacteria, species of *Pseudomonas*, *Achromobacter*, *Acidiphilum*, and *Mezorhizobium* were identified and among the archaea the dominant genera were *Thermoplasmatales* and *Sulfolobus*. Additionally, a species of the native genus *Acidianus* of Copahue was detected, which was named *A. copahuensis* and which has highly varied metabolic characteristics: it is acidophilic, thermophilic, facultative anaerobic, sulfur and iron oxidant. Finally, in LS, other thermophilic anaerobic archaea were also detected, such as *Vulcanisaeta* and *Thermocladium*. Copahue is a very interesting source of biodiversity both for its contribution to global biology and its biotechnological potential. The mineral richness of naturally matured mud and microbiota allows the treatment of a large number of dermatological, osteoarticular and rheumatological pathologies. Regarding the presentation of cases in dermatology, the following are highlighted: mud therapy combined with phototherapy in the treatment of psoriasis, and in the treatment of Rosacea and venous ulcers using cyanophytic algae bioglea. Finally, it is important to underscore the existence of a large number of cases documented each season that validate the effectiveness of treatment of different pathologies, for example the combination of mud with magnetotherapy and ultrasound in a patient with radiodermic ulcers and pain treatment combining mud therapy and galvanic therapy.