

ORIGINALRESEARCH

Traditional Knowledge and Practices of Medicinal Red Rock in Southern Morocco

Conocimientos y prácticas tradicionales de la piedra roja medicinal en el sur de Marruecos

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Abstract

Research on geomaterials is an expansive and evolving field, revealing the potential of materials such as stones, clays, and minerals across various disciplines. These materials have been utilized in traditional medicine for millennia, serving as valuable therapeutic agents in both topical and internal applications. This study focuses on El Hammira, a medicinal red stone from Southern Morocco, known for its high iron oxide content and cultural significance in local health practices. Despite its widespread use, El Hammira remains under-explored in scientific literature. To address this gap, a structured survey was conducted to gather insights from users regarding the applications, perceived effectiveness, safety considerations, challenges, and suggestions for improvement. The results indicate that 98% of respondents report high satisfaction levels, highlighting El Hammira's recognition and perceived efficacy. Significant correlations were found between satisfaction and factors such as the line of therapy, education level, age, use of mixed substances, and likelihood of recommendation. These findings underscore the urgent need for further scientific research to validate the traditional claims associated with El Hammira.

Keywords: El Hammira, Southern Morocco, Survey, Satisfaction

Resumen

La investigación sobre geomateriales es un campo en expansión y evolución que revela su potencial en diversas disciplinas, tales como piedras, arcillas y minerales. Éstos se han utilizado en la medicina tradicional durante milenios, sirviendo como valiosos agentes terapéuticos, tanto en aplicaciones tópicos como internas. Este estudio se centra en *El Hammira*, una piedra roja medicinal del sur de Marruecos, conocida por su alto contenido de óxido de hierro y su importancia cultural en las prácticas de salud locales. A pesar de su uso generalizado, *El Hammira* sigue siendo poco explorado en la literatura científica. Para abordar esta deficiencia, se realizó una encuesta estructurada recopilando la opinión de las y los usuarios sobre las aplicaciones, la eficacia percibida, las consideraciones de seguridad, los desafíos y las sugerencias de mejora. Los resultados indican que el 98 % de las y los encuestados manifiesta una alta satisfacción, destacando su reconocimiento y su eficacia percibida. Se encontraron correlaciones significativas entre satisfacción y factores como la línea de terapia, el nivel educativo, la edad, el uso de sustancias mixtas y la probabilidad de recomendación. Estos hallazgos subrayan la urgente necesidad de mayor investigación científica para validar las afirmaciones tradicionales asociadas.

Palabras clave: *El Hammira*, Sur de Marruecos, Encuesta, Satisfacción



Introduction

Research on geomaterials is a vast and ongoing field, often described as an infinite mine of knowledge and potential. These materials, including stones, clays, and minerals, offer numerous opportunities for exploration across a variety of disciplines. The scope for research is expansive, ranging from the exploration of their physical and chemical properties to the investigation of their applications in health, construction, and environmental sustainability. This endless research is further supported by advancements in technology and the development of new methodologies, which continually enhance the possibilities for innovation and discovery within geomaterials. This dynamic field remains an exciting area for ongoing investigation.

Geomaterials have been used in traditional medicine for millennia. They are applied both topically and internally for various health problems. In both traditional and modern medicine, geomaterials serve as a valuable therapeutic agent and as an inexhaustible source of research [1-3]. The uniqueness of research on geomaterials in medicine lies in the connection between various disciplines, including chemistry, physics, mineralogy, and pharmacology. This interdisciplinary approach enhances our understanding of their properties and potential applications, driving further exploration and innovation. It enables a deeper investigation into material properties, improves our understanding of mechanisms of action, and identifies new therapeutic applications.

Morocco's geological complexity creates a rich diversity of geomaterials. This diversity arises from factors such as mineral composition, formation processes (igneous, sedimentary, or metamorphic), temperature, pressure, environmental conditions and geological history. Each geomaterial has distinct properties that influence its various applications. Belghazdis et al.[4] has established a comparative database focusing on the physico-chemical, mineralogical, and thermal characteristics of clay minerals from 14 cities in Morocco. This analysis provides valuable insights into the diverse applications and properties of these clay resources. Especially since

Morocco is considered one of the top 20 global producers and consumers of clay materials [5].

A typical example is Ghassoul, a cosmetic made of natural mineral clay mined from the Atlas Mountains of Morocco, which was discovered in the 18th century and is predominantly found in the region. It is valued for its unique properties, especially in skincare and health applications. Today, it continues to attract significant research interest as scientists seek to deepen their understanding and explore new applications for this natural clay [6].

Kohl is another cosmetic geomaterial, traditionally used as eye makeup in various cultures, particularly in Asia and Africa. It is typically made from natural minerals, including galena (lead sulfide) and other minerals that provide its characteristic dark color. While kohl has historical significance and aesthetic value, its formulations can raise health concerns, particularly due to the presence of lead, which can be toxic. As a cosmetic geomaterial, kohl highlights the intersection of geology and cosmetics, emphasizing the importance of understanding the mineral composition and safety of such products [7].

El Hammira is another notable example. This medicinal red stone from Southern Morocco is characterized by its vibrant color, particularly due to its high iron oxide content. El Hammira plays a central role in the traditional medicine of the region. However, despite its extensive use in traditional medicine, El Hammira remains relatively under-explored in scientific literature. Further exploration of these properties can enhance our understanding of its unique applications in traditional and modern health practices

We began with a thorough review of the existing research literature on El Hammira. We conducted searches across several databases, including Google, Google Scholar, PubMed, Medline, Science Direct, Research Gate, and others, using relevant keywords such as "El Hammira," "Morocco," "Sahara," and "Red Stone." However, we were unable to find any relevant results. This lack of available literature on El Hammira

specifically was a primary motivation for conducting our study.

Traditional medicine, particularly the use of El Hammira, has been experiencing a gradual loss of its original knowledge. This has led to uncertainty regarding crucial aspects, such as dosage and administration. Key elements of traditional practices, including posology, precise weighing of substances, galenic preparation techniques, and the understanding of the relationship between different methods of administration, have largely been forgotten. This decline can be attributed to the oral transmission of such knowledge.

To address this gap, we conducted the first study on El Hammira with two major objectives: gathering data from users and preserving the endangered traditional medicine from further deterioration due to oral transmission, while also serving as a starting point for future research. We began our study with an online survey aimed at collecting empirical data and providing a current overview of the use of El Hammira. Moving forward, we plan to expand the research to include chemical, physical, and mineralogical characterizations of El Hammira, followed by an assessment of its effects on human cell lines.

This survey methodology gathers insights into the use of El Hammira, focusing on its applications, perceived effectiveness, safety considerations, challenges encountered by users, and suggestions for improvement. By adopting this structured approach, the research aims to validate the cultural significance of El Hammira while pinpointing areas that warrant further investigation and education. The findings will enhance our understanding of traditional healing practices and guide future research directions, fostering a more comprehensive appreciation of El Hammira's role in both cultural and medicinal contexts.

This study does not use a theoretical framework or statistical representation. It focuses on exploring the therapeutic and preventive uses of the red stone, El Hammira, particularly among people in southern Morocco. The study does not aim to connect with ethnomedicine theory but instead documents the practical knowledge and experiences of the community.

Material and Methods

Study Method for the Questionnaire

We chose an online survey for this study due to its ability to reach a wide, geographically dispersed population. This method provided an accessible and anonymous platform for participants to share their experiences, encouraging honest and detailed responses. Additionally, the online format allowed us to efficiently collect large-scale data in a short period, minimizing logistical challenges and facilitating the analysis of trends across various demographic groups. The study used an anonymous online questionnaire. It was randomly distributed via social media and email to Moroccans inside and outside the country. The language used was Classical Arabic to enhance accessibility. The questionnaire consisted of 21 questions, organized into categories that covered demographics (age, sex, educational level, city), awareness and usage of El Hammira, years of familiarity, sources of information, its medical applications, routes of administration, frequency of use, first-line versus second-line therapy, duration of application, available forms, and substances mixed with El Hammira. It also addressed the effectiveness of El Hammira (timeframe for improvement, satisfaction, willingness to recommend), safety (side effects), challenges faced by users, and suggestions for improvement.

The questionnaire was structured into four sections: an introduction outlining the research objectives, a set of questions about El Hammira usage, an optional section for participants to provide contact details for potential follow-up, and a concluding section thanking participants for their involvement. After the demographic section of the questionnaire, respondents are asked if they are a user of El Hammira. Based on their response, users proceed to the subsequent questions about usage, while non-users are automatically directed to the end of the questionnaire. The format combined both multiple-choice questions for specific data and open-ended questions for rich, personal insights. We chose to use R software [R-core Team 2021] because of its flexibility, statistical power, and open-source nature, which made it an ideal tool for our data analysis. Additionally, our proficiency with R software allowed us to

efficiently manage and analyze large datasets, ensuring robust and comprehensive results. We primarily utilized a chi squared test of independence to explore the relationship between various factors and their impact on El Hammira usage and satisfaction level, aiming for optimization, positive user experience, and satisfaction.

Results and Discussion

Usage and Socio-Demographic Profile of El Hammira Users

The online survey about El Hammira was distributed through social media and email to Moroccans both inside and outside the country. We received a total of 550 responses from 550 participants. The results were collected via Google Forms.

The data reveal that a high proportion of respondents were unaware of El Hammira (61%) and that most respondents have not used El Hammira for medicinal purposes (Fig 1). The questionnaire was randomly distributed and covers about 50 Moroccan cities, as well as Moroccan residents living abroad. The majority of El Hammira users are from Laayoune at 65%, followed by Es-Smara at 15%, Dakhla at 4%, Tantan at 3%, with the final 13% from all other cities (Fig 2). The limited use of El Hammira is due to its cultural significance among indigenous groups in the Moroccan Sahara and its regional availability, which restricts broader adoption. According to the document from the Moroccan Ministry of Energy, Mines, Water, and Environment and the geological map of Es-Smara, the El Hammira deposits are outcrops primarily in Labtayniya and Khrebichat formations, located in the north and north-west of the Es-Smara region.

Females exhibit the highest usage of El Hammira (p -value = 0.0397). The "36 to 55" age groups tend to report higher usage rates compared to others. Elderly and male populations are underrepresented. Women and young individuals often benefit from strong community networks that promote traditional therapies, perceived as safer and less invasive than pharmaceuticals. Individuals with lower education levels show greater usage of

El Hammira compared to those with higher education levels. This could be explained by the fact that highly educated individuals often prioritize evidence-based medicine and scientific validation.

El Hammira users' experiences

Topical uses of El Hammira were more common than oral uses, likely due to safety concerns, familiarity, and cultural beliefs. Both topical and oral applications of clay minerals are effective, each utilizing distinct mechanisms related to element mobility and exchangeability [8].

Figure 1. El Hammira User vs. Non-User Distribution

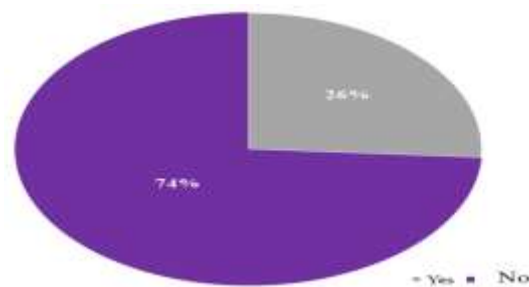
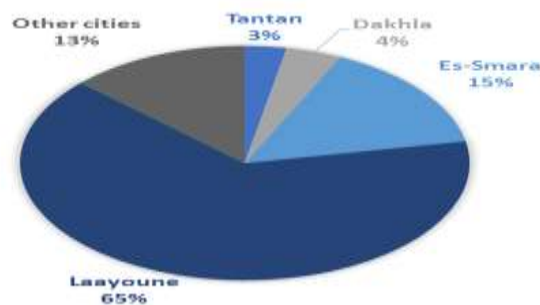


Figure 2. City Distribution Among El Hammira Users



Note: The source of the graphs is Excel 2016, generated from data collected via a Google Forms survey.

Results of the survey show that there are many uses of El Hammira, but the histogram in Figure 3 is limited to the top 10 most common applications. The x-axis represents various medical uses, while the y-axis shows the number of users. The top 10 most common uses of El Hammira (Fig. 3), listed from the most frequent to the least frequent, are as follows: bruises, stye, cataracts, muscle and joint pain, swelling, wounds, eye inflammation, burns,

psoriasis, and eczema. These uses were classified into three categories: skin conditions, including bruises, wounds, burns, psoriasis, eczema, and swelling, where El Hammira is commonly used for its soothing and healing properties; eye conditions, such as stye, eye inflammation, and cataracts, where the stone is believed to reduce irritation and promote eye health; and musculoskeletal issues, such as muscle and joint pain, where El Hammira is used to relieve discomfort and inflammation.

Additional reported uses include childhood diarrhea, miscarriage, migraine, depression, cysts, zona, menstrual cramps, fertility, fever, general sexual health and spiritual healing. Isabel Carretero’s study supports the effectiveness of topical uses such as cosmetic treatments.^[9] In the open-ended questions regarding the uses of El Hammira, respondents also mentioned its veterinary applications to improve cattle health. These uses highlight their role not only in human health but also in treating animals.

Morocco has experienced a range of epidemics, including plague, typhus, cholera, smallpox and typhoid, from the 15th century up to the Covid-19 pandemic. Some of these epidemics originated from the Mashreq or from Europe, often linked to the movements of armies, pilgrims, and international trade. Additionally, these outbreaks were frequently accompanied by droughts, locust invasions, famine, and civil wars, which had varied impacts on Moroccan society.^[10]

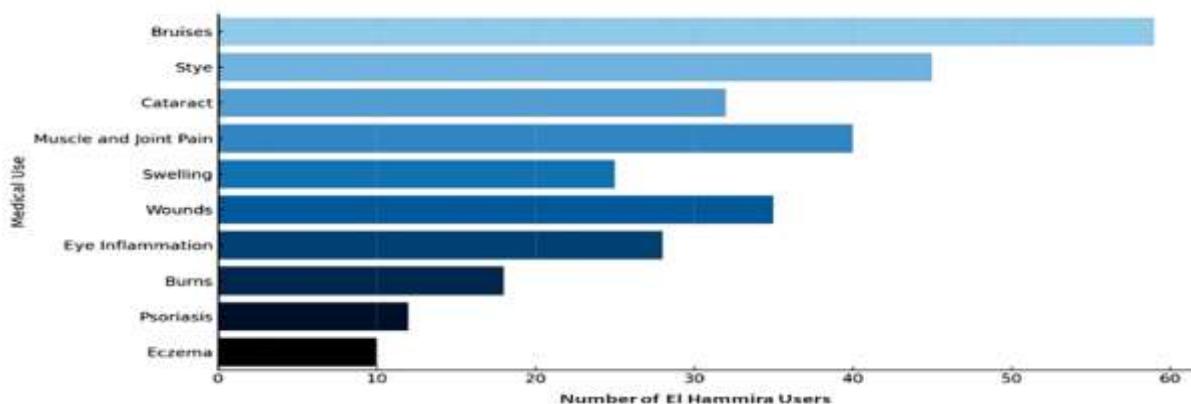
In the context of the Spanish Protectorate in Morocco, several epidemics significantly affected both the local population and the Spanish military.

Among the most prominent diseases were malaria, bubonic plague, cholera, leprosy, dysentery, tuberculosis, syphilis, gonorrhea, scabies, and smallpox.^[11-14]

In response to these recurring crises, traditional medicine played a pivotal role in Moroccan society. Remedies like El Hammira were developed from centuries of accumulated knowledge, often passed down through generations. The geographic location of the Sahara, being far from the central areas and lacking easy access to healthcare centers, further highlights the reliance on El Hammira as a traditional remedy. The risk of not using El Hammira, particularly in the absence of accessible healthcare, could lead to worsened health conditions, prolonged suffering, and further exacerbation of common ailments like skin issues, burns, or respiratory problems.

On the other side, El Hammira is used by the Indigenous population of the Oceanic Sahara, a region known for its unique climate and geographic features, where harsh environmental factors such as frequent sandstorms and the presence of salty water can influence the health of the local population. The constant exposure to dust, dry air, sun, sand, and wind are almost inevitable. Intense exposure to these conditions may exacerbate skin problems like dehydration, burns, wounds, psoriasis, and eczema, as well as eye irritations and respiratory issues. It seems like El Hammira is not merely a remedy people turn to when they're sick, but also a preventive measure to help manage these conditions before they escalate.

Figure 3. The Top 10 Most Common Medical Uses of El Hammira



The results show that 80% of respondents learned about El Hammira through family traditions. In Moroccan families, elderly members hold valuable knowledge of traditional remedies, which are valued for their simplicity and effectiveness. These remedies, passed down through generations, highlight the strong influence of familial and cultural traditions on personal health practices.^[15] The World Health Organization (WHO) reported that 80% of the emerging world's population relies on traditional medicine for therapy. In regions like the Oceanic Sahara, El Hammira is deeply intertwined with local customs, beliefs, and practices passed down through generations. This cultural significance often extends beyond healing physical ailments—it represents a deep connection to heritage, community, and the natural environment. The knowledge of such remedies is not only a practical response to health challenges but also an expression of cultural identity and resilience. There exists a debate in these regions about traditional medicine, with one side holding traditionalist and culturalist positions that often carry anticolonial sentiments, exalting the prestigious past of Arabic and Islamic culture, art, and science. The confidence in these views is naturally strengthened whenever modern medicine makes mistakes. On the other hand, a second group sees traditional medicine in terms of its irrational and miraculous elements, while still acknowledging its cultural importance.^[14]

Preference for El Hammira is deeply rooted in its tradition, where it offers not only effective therapeutic benefits but also a sense of accessibility. Traditional remedies like El Hammira are locally sourced and readily available, fostering a deep sense of trust and continuity. The limitations and failures of conventional medicine have only strengthened this conviction. The cost-effectiveness of traditional remedies also plays a significant role, as they are often more affordable compared to conventional treatments, making them an attractive option for many.^[15]

Of those who do use El Hammira, most respondents (51%) reported using it as their first-line therapy. Additionally, 52% of respondents have been using El Hammira for over two decades. Most users rely on traditional therapy as their first-line treatment and often continue to do so for

extended periods. This is evident in the clientele of traditional medicine, including new users, and reflects a broad adherence to traditional practices among the population.^[15]

A majority (68% of respondents) use El Hammira specifically in response to health problems. This selective approach highlights its function as a specific remedy rather than for regular application. This lack of consistent use may be due to unclear instructions, forgetfulness, accessibility issues, or inconvenience.

More than half of users apply El Hammira for over one day, likely due to cultural beliefs in prolonged use for optimal results. In contrast, 20% of respondents use it for 30 minutes to one hour, possibly to mitigate health risks. Studies suggest that using other geomaterials, like kohl, for shorter durations can reduce exposure to harmful substances, although it does not eliminate risks entirely. Limiting application time helps individuals balance the benefits of traditional cosmetics with their potential dangers.^[16]

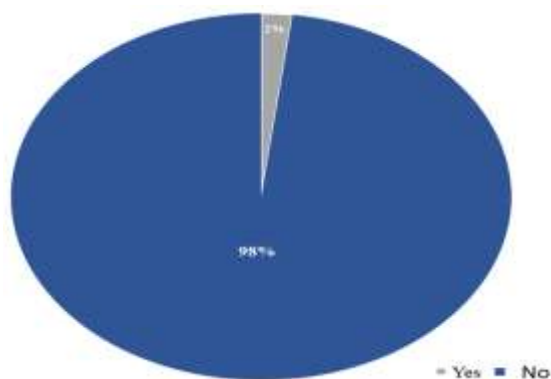
According to 75% of users, El Hammira is most commonly available in its rock form, indicating that this form of El Hammira is the most accessible and possibly the most preferred option for consumers, like Ghassoul. Historically used in Morocco and officially regulated since 1786. Today, Ghassoul is still used in its raw form, reflecting Moroccans' preference for natural, authentic materials over industrial products.^[17]

El Hammira requires a complex preparation process before being used externally or even consumed as a drinkable mixture. A notable 73% of users mix El Hammira with animal fat for its emulsifying, moisturizing, and stabilizing properties. A minority of users (8%) mix El Hammira with gum Arabic (GA). GA has anti-inflammatory, prebiotic, and antibacterial properties.^[18] Some respondents suggested mixing El Hammira with rose water, which may be due to its soothing, aromatic, and moisturizing properties. Some respondents claim that they use EL Hammira without mixing it with other substances, possibly due to the influence traditional practices, perceived purity, and the fear of interactions with other substances. The majority (60%) of El Hammira

users notice benefits within a day of application. A minority (3.8%) find the El Hammira to be completely ineffective. This disparity may be due to a combination of personal factors, such as individual expectations, subjective perceptions, genetic makeup, and pre-existing health conditions, as well as application-related factors such as variations in usage frequency and methods, inconsistencies in the formulation, or concentration of El Hammira. Figure 4 presents a 2D pie chart illustrating the survey findings, with 98% of users reporting no side effects and only 2% experiencing some side effects. These results suggest that El Hammira is mostly well-tolerated and has a favorable safety profile.

The adverse effects, even with a small percentage, may be attributed to the presence of harmful substances, as mentioned in the literature, such as Arsenic, Cadmium, and Lead, which are found in low levels in some clay samples.^[19-23]

Figure 4. Percentage Distribution of Side Effects Reported by El Hammira Users



Note: The source of the graphs is Excel 2016, generated from data collected via a Google Forms survey.

Based on the questions about usage, we can conclude that El Hammira is primarily used as an application in response to health issues, specifically through topical use. To ensure its effectiveness and safety, it is essential to follow traditional guidelines and avoid contraindications. Additionally, verifying the authenticity of the stone is crucial, as only genuine El Hammira retains its full therapeutic properties. By adhering to these guidelines, El Hammira can provide safe and

effective therapeutic benefits. The majority of users (68%) would recommend El Hammira without any reservations. El Hammira is highly and continually recommended because of its benefits. El Hammira offers notable benefits in treating skin, eye, and musculoskeletal issues, with many users experiencing rapid relief. It is widely trusted as a first-line therapy, with high level of satisfaction and no significant side effects reported. Its longstanding use, spanning over two decades for many, reflects its enduring effectiveness. Beyond its therapeutic value, El Hammira is deeply embedded in cultural and social traditions, symbolizing a vital aspect of communal identity and prestigious Arab heritage, passed down through generations. Its continued use reinforces social bonds within the community.

Users emphasize that every home should have El Hammira, and that it should be used exclusively for topical applications. While most users reported positive experiences, the 2% of users who experienced side effects are also important to note. The specific nature of these side effects was not detailed in the open-ended questions. These side effects may cause some users to recommend regular but moderate use, and it is crucial to verify the authenticity of El Hammira before use. Additional precautions include avoiding eye contact and not applying it to fresh wounds.

Half of users struggle with acquiring the right quality of El Hammira. 47% of respondents highlight the absence of robust evidence supporting its therapeutic benefits. Additional barriers identified by users include the high cost of El Hammira, and the difficulties in preparing the stone into a fine powder, which complicates its use.

Users of El Hammira suggest advocating for research in *Hassaniya* (local Arabic dialect), addressing the lack of scientific validation, conducting surveys with traditional healers and providing El Hammira in powdered form. These recommendations closely align with the challenges users have identified, aiming to resolve the very issues they experience.

Based on the open-ended responses regarding recommendations and side effects of El Hammira,

we concluded several important contraindications for its use. El Hammira should not be ingested, and it is advised to avoid applying it to fresh wounds to prevent complications like inflammation. Additionally, eye contact should be avoided. Excessive use is discouraged. El Hammira should also be kept away from sunlight. These precautions are essential to ensure safe and effective use while minimizing any potential risks.

Analysis of Satisfaction among El Hammira users

A significant majority (98%) of El Hammira users report positive satisfaction levels, responding either as "Very Satisfied" or "Somewhat Satisfied". This indicates that El Hammira is well recognized and appreciated, with the majority finding it to meet or exceed their expectations. Significant dependence was found between satisfaction and several variables: line of therapy ($p = 0.0264$), education level ($p = 0.0031$), age ($p = 0.0374$), mixed substances ($p = 0.0013$), and tendency to recommend ($p = 0.00007$). Non-significant dependence was found between satisfaction and gender ($p = 0.9452$), challenge ($p = 0.5697$), and routes of administration ($p = 0.0910$).

Conclusion

El Hammira, a red stone from Southern Morocco, stands out for its historical and ongoing use in traditional medicine. Despite its widespread application, this study represents the first scientific exploration of El Hammira, aiming not only to preserve this traditional remedy from the deterioration caused by purely oral transmission but also to serve as the foundation for future research.

The findings of this study highlight the high level of satisfaction among El Hammira users, with the remedy most applied topically for skin conditions, eye conditions, and musculoskeletal issues. Significant correlations were identified between satisfaction and factors such as therapy type, education level, age, use of mixed substances, and the likelihood of recommending El Hammira. Beyond direct user satisfaction, positive sentiment is reflected in its use as a first-line therapy and the long-standing trust it has earned within the

community. El Hammira's deep cultural roots in Moroccan tradition, with most users learning about it through family practices, further underscore its enduring effectiveness. The high rate of recommendations points to users' strong confidence in its therapeutic benefits.

However, while users express satisfaction and trust, they remain aware of the lack of scientific proof supporting its claims, which they view as a challenge.

In conclusion, the study affirms El Hammira's significant cultural role and widespread use in Southern Morocco, with users reporting high levels of satisfaction and trust. The findings underscore the importance of further scientific research to validate its traditional claims, particularly its chemical, physical, and therapeutic properties. Such validation could enhance our understanding of El Hammira's mechanisms of action and facilitate its safe and effective integration into modern health practices.

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