

Argan Futures: Overcoming Obstacles to the Effective Utilization of Scientific Findings in Ar gan Cultivation and Conservation

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ABSTRACT

Argania Spinosa plays a crucial socioeconomic role in Morocco. In recent decades, scien- tific research has substantially advanced, particularly in the valorization of argan prod- ucts. This research primarily focuses on determining the chemical composition and key biological activities of argan oil. These bioactive products find applications in cosmetics, medicine, pharmaceuticals, and various industrial sectors. Concurrently, other studies concentrate on aspects such as plant growth, climate impact, biodiversity preservation, and environmental conditions affecting argan trees. However, it's notable that a signifi- cant proportion of research efforts in Morocco (around 62%) are directed towards the eco- nomic valorization of argan rather than ecological conservation. Research endeavors on argan need to strike a balance between economic exploitation and ecological preservation. Additionally, efforts should be made to effectively disseminate research findings to farm- ers, empowering them to protect this endemic tree species and enhance argan cultivation levels across the country. The aim of this study is to highlight the research conducted on the Argan tree and raise awareness among local and scientific communities to direct re- search towards preserving this national heritage, which is severely affected by these cli- mate changes.

Keywords

Argania Spinosa,
valorization, conservation

RÉSUMÉ

Argane Futures : surmonter les obstacles à l'utilisation efficace des résultats scientifiques dans la culture et la conservation de l'arganier

Argania Spinosa revêt une importance socioéconomique majeure au Maroc. Au cours des dernières décennies, les avancées scientifiques ont largement contribué à la valorisation des produits issus de l'arganier, avec un accent particulier sur l'analyse de la composition chimique et des propriétés biologiques de l'huile d'argan. Ces produits bioactifs sont exploités dans divers domaines, notamment la cosmétique, la médecine, la pharmacie, ainsi que dans d'autres secteurs industriels. En parallèle, d'autres études se focalisent sur la croissance de l'arganier, l'influence de changement climatique, la conservation de la biodiversité de cette espèce. Néanmoins, il est important de noter qu'une part significative de la recherche au Maroc (environ 62%) se concentre

Mots clés

Arganier, rhizosphère,
abondance microbienne.



principalement sur la valorisation économique de l'arganier, au détriment de la conservation écologique. Il est essentiel que les recherches sur l'arganier au Maroc trouvent un équilibre entre l'exploitation économique et la préservation écologique de ce patrimoine. De plus, il est crucial de mettre en place des stratégies de diffusion des résultats scientifiques auprès des agriculteurs, afin de les exploiter pour la protection et la valorisation d'arganier. Cette étude vise à mettre en lumière direction des recherches scientifiques sur l'arganier et à sensibiliser les communautés locales et scientifiques sur l'importance de réorienter les efforts de recherche vers la préservation de ce patrimoine national, fortement menacé par les changements climatiques actuels.

1. INTRODUCTION

The argan tree (*Argania spinosa* (L.) Skeels; syn *A. sideroxylon* Roem & Schult.) belongs to the Sapotaceae family and is the only species of this tropical family found in the sub-tropical zone. The thorny evergreen tree grows endemically in Morocco, mainly on the western side of the High Atlas, and has also been propagated in Israeli deserts [1-3] In Morocco, this crop plays a significant role in the economy and culture of Morocco. The extraction of argan oil provides income for many rural communities, particularly women who are involved in the traditional production process. The argan forest also serves as a habitat for various plant and animal species, contributing to biodiversity conservation [4- 5]. Furthermore, argan oil, extracted from the seeds of the argan tree, is highly valued for its culinary, cosmetic, and medicinal properties. It is rich in essential fatty acids, antioxidants, and vitamin E. Culinary argan oil is used for cooking and as a condiment, while cosmetic argan oil is used in skincare and haircare products [6-9]. *Argania spinosa* and the argan forest ecosystem face threats from factors such as overgrazing, deforestation, and climate change. Efforts are being made to conserve and sustainably manage the argan forests to ensure the long-term viability of both the tree and the ecosystem it supports [10- 12]. In this study, we will present the state of the art of scientific production and how the findings can be of use to farmers for the conservation of the argan tree in Morocco.

2. MATERIALS AND METHODS

The data used in this work were obtained from Google Scholar using "Argania; arganier; argan" in the title of the document between 1900 and 2023. 1160 documents were obtained and used to analyze the development of document numbers

by year. Among these documents, we selected 510 documents published in Scopus to analyze the development of these documents by country and subject area. In addition, the VOSviewer software (version 1.6.20) was used to construct and visualize bibliometric networks. In addition, a co-occurrence analysis of keywords and co-authorship of countries was performed.

3. RESULTS

3.1. Development of scientific production on the argan tree

The results showed that the cumulative number of documents increased from 1900 to 2023 with an average of 1160 documents in 2023, while the highest number of documents by year was obtained in 2020 with an average of 67 documents followed by 2023 (65 documents) (Fig 1).

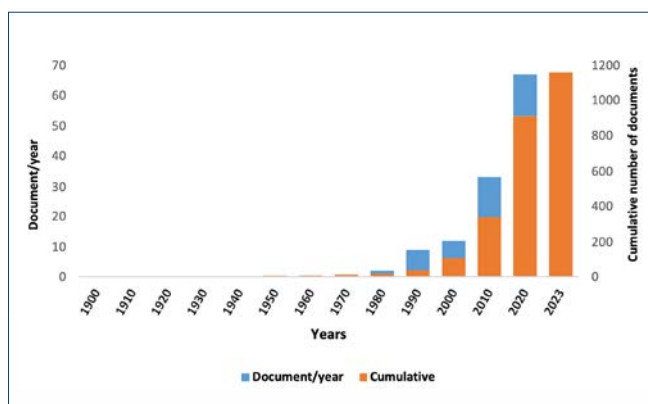


Fig 1 : Development of documents number by year

According to data from Scopus from 1981 to 2024, the highest number of documents by country or territory was recorded in Morocco with an average of 511 documents followed by France and Spain (158 and 83 documents respectively) (Fig 2). By subject area, 22 % of the documents total were obtained in Agricultural and Biological Sciences followed by



Biochemistry, Genetics, and Molecular Biology and Chemistry with an average of 11%.

Environmental Sciences, Medicine, and

Pharmacology, Toxicology and Pharmaceutics areas showed an average of 6-8 %, while the lowest value was obtained in Social Sciences (Fig 3).

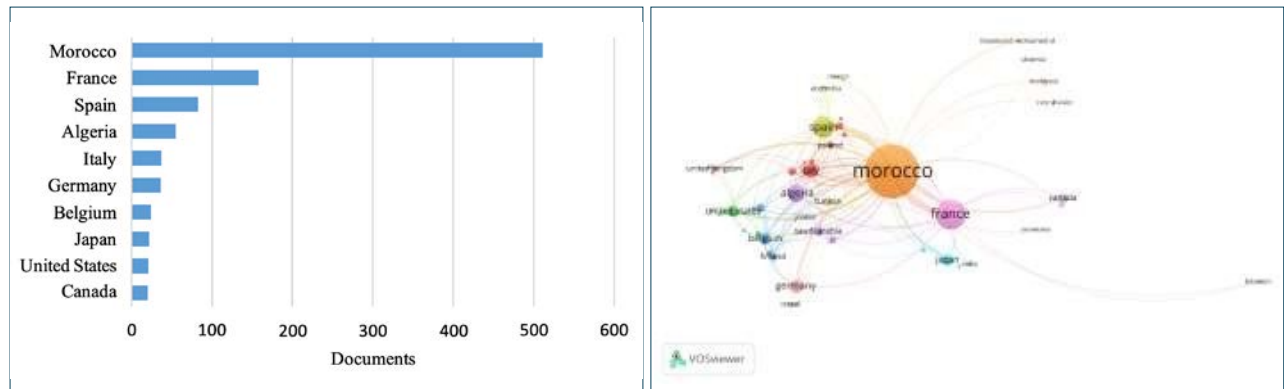


Fig 2 : Development of documents number by country or territory

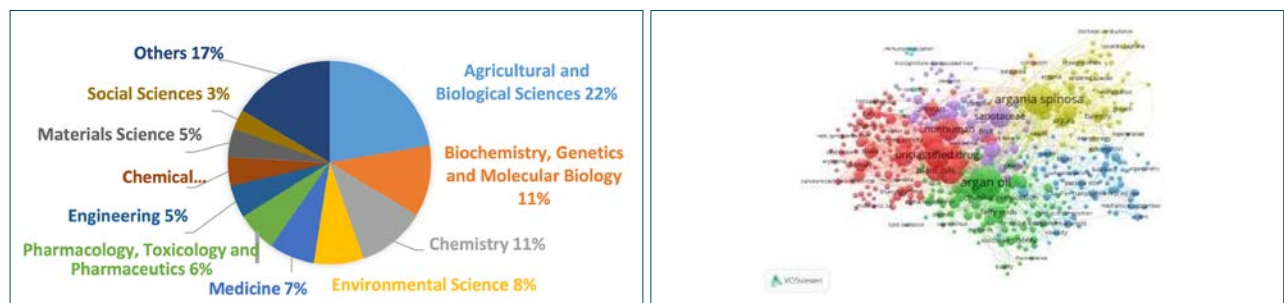


Fig 3 : Development of documents number by subject area

3.2.Key challenges of cultivating argan trees in Morocco

Cultivating argan trees in Morocco presents several challenges, including climate change, limited water resources, pest and disease management, traditional farming methods, limited access to markets, lack of technical knowledge, conservation concerns, and regulatory issues.

technical knowledge, conservation concerns, and regulatory Issues. Furthermore, It 's estimated that a significant portion of research is likely dedicated to the economic valorization of argan with an average of 62 % while the ecological conservation present 38 % of global research in Morocco (Fig 4).



Fig 4 : Key challenges of cultivating argan trees in Morocco



3.3. Strategies to overcome obstacles to the effective utilization of scientific findings in argan cultivation and conservation

To overcome obstacles to the effective utilization of scientific findings in argan cultivation and conservation, several strategies can be implemented such as Technology Transfer, Research Prioritization, Policy Support, Incentive Mechanisms, Community Engagement, Knowledge Exchange Platforms and Capacity Building (fig 5).



Fig 5 : Strategies

5. DISCUSSION

The scientific research on the argan tree has seen a notable increase in recent decades. This surge in interest reflects a growing recognition of the ecological, economic, and cultural importance of the argan tree and its unique ecosystem. In Morocco, it's estimated that a significant portion of the research is likely dedicated to the economic valorization of argan (62%), given its economic importance for Morocco as an export product and its potential for socio-economic development in producing regions. This may include studies on the quality and properties of argan oil, research on new applications in the food, cosmetic, and pharmaceutical industries, as well as efforts to improve yields and profitability of production [13-15]. On the other hand, the ecological conservation of argan and its associated ecosystem is also a major concern due to the environmental value and biodiversity of the argan forest. A substantial portion of research is therefore likely to focus on

issues such as deforestation, habitat restoration, biodiversity monitoring, sustainable natural resource management, and the impacts of climate change on argan forests [16-18]. Overall, research on argan in Morocco should strike a balance between economic valorization and ecological conservation, recognizing the importance of both perspectives in ensuring sustainable development and effective management of this valuable resource.

The argan tree faces several conservation concerns due to various factors impacting its habitat and population. Also, balancing argan cultivation with conservation efforts to protect the endemic tree and its unique ecosystem poses challenges for sustainable management. To overcome obstacles to the effective utilization of scientific findings in argan cultivation and conservation, several strategies can be implemented such as facilitate the transfer of appropriate technologies and innovations from research institutions to local communities, such as improved seed varieties, irrigation techniques. Also, prioritize research that addresses knowledge gaps and emerging challenges in argan cultivation and conservation, such as climate change resilience, pest and disease management, genetic diversity conservation, and socio-economic impacts of conservation interventions. Furthermore, advocate for policies that integrate scientific research findings into land-use planning, natural resource management, and conservation strategies at the local, regional, and national levels. Additionally, invest in educational programs and training workshops for local farmers, extension workers, and conservation practitioners to enhance their understanding of scientific findings related to argan cultivation and conservation [12], [19-21].

CONCLUSIONS

The argan forest possesses considerable financial, ecological, and cultural significance in Morocco. Despite advances in scientific study, it is essential to balance commercial valorization with ecological conservation to ensure the continued development of this rich resource. The obstacles encountered in argan cultivation, including climate change, restricted water availability, and conventional agricultural practices, require targeted strategies including technology transfer, research prioritization, policy support, and community



involvement. The dissemination of scientific research and the empowerment of local farmers via targeted initiatives can improve argan production and conservation efforts, thereby ensuring the preservation of this national heritage for future generations.

RÉFÉRENCES BIBLIOGRAPHIQUES

1. Morton JF, Voss GL. The argan tree (*Argania sideroxylon*, sapotaceae), a desert source of edible oil. *Econ Bot.* 1987 Vol 41(2):221–33.
2. Benchekroun F, Buttoud G. L'arganeraie dans l'économie rurale du sud-ouest marocain. *Forêt Méditerranéenne.* 1989 (2):127– 36.
3. Nerd A, Eteshola E, Borowy N, Mizrahi Y. Growth and oil production of argan in the Negev Desert of Israel. *Ind Crops Prod.* 1994 Vol 2(2): pp 89–95.
4. Charrouf Z, Guillaume D. Ethnoeconomical, ethnomedical, and phytochemical study of *Argania spinosa* (L.) Skeels. *J Eth- nopharmacol.* 1999 Vol 67(1): pp 7–14.
5. Barkaoui M, Msanda F, Boubaker H, El-Boullani R, El Asri O, Chokri A, et al. Ethnobotany, traditional knowledge, and nutritional value of Argan (*Argania spinosa* (L.) Skeels) in Western Anti-Atlas of Morocco. *Brazilian Journal of Biology* 2022, Vol 84(10):e260477.
6. Moukal A. L'arganier, *Argania spinosa* L. (skeels), usage thérapeutique, cosmétique et alimentaire*. *Phytothérapie* 2004 Vol 2(5):135–41.
7. Charrouf Z, Guillaume D. Secondary metabolites from *Argania spinosa* (L.) skeels. *Phytochemistry Reviews* 2002, Vol 1(3):345–54.
8. Ait Aabd N, El Asbahani A, El Alem Y, El Finti A, Msanda F, El Mousadik A. Variation in oil content and fatty acid com- position in preselected argan trees with morphological characters and geographical localization. *Med J Nutrition Metab.* 2013, Vol 6(3):217–25.
9. Olojo FO, Akinrinde AS, Ogundairo SA, Ubochi VC. *Argania spinosa* essential oil ameliorates colonic damage and ex- traintestinal alterations in a rat model of acetic acid-induced colitis by suppressing oxidative stress and inflammation. *Ad- vances in Traditional Medicine* 2023, pp 1–16.
10. Ezaidi S, Haddou MA, Kabbachi B, Ezaidi A, Aichi A, Das P, et al. Forest Degradation Susceptibility and Sustainability: Case Study of Arganeraie Biosphere Reserve, Atlantic High Atlas, Morocco. *Forest Degradation Susceptibility and Sustain- ability: Case Study of Arganeraie Biosphere Reserve, Atlantic High Atlas, Morocco* In : *Geospatial Practices in Natural Resources Management* Cham : Springer International Publishing 2024, 5 07–26.
11. Moukrim S, Lahssini S, Rhazi M, Alaoui HM, Benabou A, Wahby I, et al. Climate change impacts on potential distribution of multipurpose agro- forestry species: *Argania spinosa* (L.) Skeels as case study. *Agroforestry Systems* 2019, Vol 93(4):1209–19.
12. El Ghiouan S, Boujrourf S. Innovation and the Sustainable Development in the Arganeraie Biosphere Reserve (ABR). *Studies in Big Data* 2024, Vol 143, pp 75–93.
13. Kebbjaj R El, Bouchab H, Tahri-Joutey M, Rabbaa S, Limami Y, Nasser B, et al. The Potential Role of Major Argan Oil Compounds as Nrf2 Regulators and Their Antioxidant Effects. *Antioxidants* 2024, Vol 13(3): p 344.
14. Khattabi L, Dakkach M, Bouziane H, Allouch M. Physicochemical properties, antioxidant, and antibacterial activity of *Ar- gania Spinosa* honey produced only in Morocco: Application in the care of surgical wounds. *Moroccan Journal of Chemistry* 2023, pp1038-1056.
15. Rahim S, Bellali F, Bennani M, Sabiri C, Derouiche A, Rahim S. Secondary Metabolites And Antioxidant Activity Of *Ar- gania Spinosa* (L.) Almonds Cultivated In The Three Region Of Morrocco. *Journal of Namibian Studies : History Politics Culture.* 2023, Vol 35:24 pp 10–23.
16. Alami M, Belkadi B, Yatrib C, Medraoui L, Pakhrou O, Rabeh K, et al. Dynamics of Tree Cover on the Adaptive Genetic Variation and Evolutionary Power of the Argan Forests from the Essaouira Region of Morocco Facing Climate Change. *Environmental Science and Engineering* 2023, pp 187–205.
17. Ait Aabd N, Bouharroud R, Tahiri A, Wifaya A, Mimouni A, Mousadik A El. Genetic diversity and breeding of argan tree (*Argania spinosa* l. skeels). *Advances in Plant Breeding Strategies: Nut and Beverage Crops* 2020 , Vol 4, pp 31–56.

18.Chakhchar A, Haworth M, El Modafar C, Lauteri M, Mattioni C, Wahbi S, et al. An assessment of genetic diversity and drought tolerance in argan tree (*Argania spinosa*) populations: Potential for the development of improved drought tolerance. *Front Plant Sci* 2017, 8:234286.

19. Kesavan P. Enablers of Organisational Learning, Knowledge Management, and Innovation: Principles, Process, and Practice of Qualitative Data. Springer Nature. Springer Singapore 2020. pp1–308.

20.Balslev H. Entrepreneurship and the Sustainable Development Goals. The bargain power of organ in Morocco. *Geoforum.dk*. 2024

21.Perry W. Social sustainability and the argan boom as green development in Morocco. *World Dev Perspect*. 2020 1;20:100238.