THE FUTURE OF HIGH-VALUE MEDICINAL AND AROMATIC PLANTS

Abstract

The future of “High-Value Medicinal and Aromatic Plants" is a captivating exploration of the multifaceted significance, current landscape, and promising trajectory of high-value Medicinal and Aromatic Plants (MAPs). This chapter delves into their roles in health, economics, culture, and sustainability. It showcases their historical roots, contemporary applications, and pivotal positions in global industries, from pharmaceuticals to culinary. High-value MAPs are more than commodities; they are repositories of cultural heritage. The chapter discusses their economic importance, regions for cultivation, and emerging trends. It also highlights their vital roles in pharmaceuticals and nutraceuticals through compelling case studies. High-value MAPs enrich global cuisines, shaping culinary traditions and sensory experiences. The chapter looks to the future, addressing challenges and opportunities while emphasizing sustainability, market trends, research prospects, and their contributions to food security, health, and sustainability.

Keywords: High-value medicinal and aromatic plants, traditional healing, aromatherapy, economic impact, biodiversity conservation

Authors

Amit Kumar Tiwari
CSIR – Central Institute of Medicinal and Aromatic Plants
CSIR – Central Institute of Medicinal and Aromatic Plants
Research Centre Pantnagar
PO. Dairy farm Nagla
Uttarakhand, India.
amitkumartiwari.cbg@gmail.com

Prawal P S Verma
CSIR – Central Institute of Medicinal and Aromatic Plants
CSIR – Central Institute of Medicinal and Aromatic Plants
Research Centre Purara
PO. Gagrigole via Garur, Bageshwar
Uttarakhand , India.
prawalpratapsv@gmail.com

Sonveer Singh
CSIR – Central Institute of Medicinal and Aromatic Plants
CSIR – Central Institute of Medicinal and Aromatic Plants, Research Centre Pantnagar
PO. Dairy farm Nagla
Uttarakhand, India.
Sonvir.babba@gmail.com

Dipender Kumar
CSIR – Central Institute of Medicinal and Aromatic Plants
CSIR – Central Institute of Medicinal and Aromatic Plants
ResearchCentre Pantnagar
PO. Dairy farm Nagla
Uttarakhand, India .
dkonarya@gmail.com

R C Padalia
CSIR – Central Institute of Medicinal and Aromatic Plants
CSIR – Central Institute of Medicinal and Aromatic Plants
ResearchCentre Pantnagar
PO. Dairy farm Nagla
Uttarakhand, India.
rc.padalia@cimap.res.in

R. K Upadhyay
CSIR – Central Institute of Medicinal and Aromatic Plants
CSIR – Central Institute of Medicinal and Aromatic Plants
ResearchCentre Pantnagar
PO. Dairy farm Nagla
Uttarakhand, India.
rkupadhyayfzd@yahoo.com

I. INTRODUCTION

In the realm of health and well-being, high-value MAPs are renowned for their multifaceted contributions. Abundant in bioactive compounds, Medicinal plants have established a renowned reputation for their healing, preventive, and therapeutic properties, contributing significantly to the realm of traditional healing traditions(Ur-Rahman et al., 2019). On the other hand, aromatic plant weave enchanting scents and enhance flavors, orchestrating sensory experiences in aromatherapy, culinary, and fragrance production. The economic impact of MAPs resonates profoundly due to their widespread demand. These plants serve as cornerstones in diverse industries, ranging from pharmaceuticals and cosmetics to culinary industry and fragrance production(Mathela et al., 2021). Their global desirability bestows substantial economic value, propelling international trade and fostering economic growth. High-value MAPs are not merely commodities; they are repositories of cultural heritage deeply rooted in historical narratives and traditional wisdom. They hold integral positions in cultural legacies, participating in spiritual rituals, enriching culinary traditions, inspiring art, literature, folklore, and preserving cultural identity. Sustainability assumes a paramount role in the context of MAPs(Nazim et al., 2020). The cultivation and conservation of these plants are indispensable, not only to ensure a continuous supply of these invaluable resources but also to protect their natural habitats. Sustainable practices in MAP cultivation act as safeguards against overharvesting and habitat degradation, championing ecological harmony and biodiversity conservation. This chapter endeavors to meticulously unravel the intricate significance of high-value MAPs. It traces their historical roots, explores their contemporary applications, and charts a promising trajectory for the future—a trajectory woven with threads of health, economic prosperity, cultural richness, and environmental sustainability(Shukla et al., 2022).

High-value MAPs are of paramount importance, encompassing a multifaceted array of contributions to diverse facets of human life and the global economy(Kalita & Khan, 2013). Firstly, they hold a pivotal role in health and well-being as these plants constitute a rich source of therapeutic compounds, serving as foundational elements in traditional medicine systems globally and forming the basis for numerous pharmaceutical drugs and natural health products. Moreover, from an economic perspective, MAPs are prized commodities on the global market, their cultivation and trade significantly impacting the livelihoods of farmers and local communities alike(Rubab et al., 2022). Their uniqueness often commands premium prices, rendering them indispensable in the economic landscape. Furthermore, MAPs are deeply ingrained in cultural heritage, intertwined with practices, rituals, and traditional knowledge. They are vital in religious ceremonies, perfumery, and cuisine, adding a layer of cultural significance(Bargali et al., 2022). The culinary benefit from aromatic MAPs like herbs and spices, as they infuse dishes with enhanced flavors and aromas, contributing to the diversity of global culinary traditions. In an era marked by growing environmental concerns, certain high-value MAPs have emerged as champions of sustainability. Their cultivation, when managed responsibly, fosters sustainable agricultural practices, as some are uniquely adapted to specific ecosystems, allowing for biodiversity conservation and the protection of natural habitats. Simultaneously, MAPs serve as catalysts for research and innovation, captivating scientific curiosity due to their distinct chemical profiles. These profiles open doors to potential solutions in drug discovery, alternative medicine, and various industries, making ongoing research an imperative in addressing evolving health challenges (Chaachouay et al., 2019).

Additionally, high-value MAPs play a substantial role in global trade, contributing significantly to international commerce. The burgeoning global demand for these plants has facilitated cross-border exchanges and the development of intricate supply chains spanning continents. These MAPs' intrinsic bioactive compounds, including essential oils, alkaloids, and polyphenols, endow them with antioxidant, anti-inflammatory, and antimicrobial properties, rendering them indispensable in an array of industries. In essence, high-value MAPs are not only reservoirs of healing and aromatic compounds but also cultural treasures, economic powerhouses, and crucial drivers of sustainability and innovation, encompassing a wide-reaching significance that transcends conventional boundaries.

This chapter endeavors to meticulously unravel the intricate significance of high-value MAPs. It traces their historical roots, explores their contemporary applications, and charts a promising trajectory for the future—a trajectory woven with threads of health, economic prosperity, cultural richness, and environmental sustainability. As we delve deeper into the chapters that follow, we will unveil the remarkable journey of these plants and their profound impact on our world.

II. CURRENT LANDSCAPE OF HIGH-VALUE MAPS

The current landscape of high-value MAPs presents a captivating tapestry of botanical diversity with profound economic significance. These plants, often hailed as nature's pharmacy and fragrance cupboard, encompass a wide array of species cherished for their therapeutic and aromatic properties (Zhong et al., 2018). High-value MAPs encompass a diverse range of plant species that are primarily valued for their medicinal, aromatic, or culinary properties. These plants are often characterized by the presence of bioactive compounds, essential oils, alkaloids, and polyphenols, which imbue them with their unique properties. They find application in traditional healing systems, culinary arts, perfumery, and a multitude of industries. One hallmark of high-value MAPs is their versatility (Schuhmacher et al., 2021). Medicinal MAPs have been revered for centuries in traditional medicine systems across cultures. From the Ayurvedic herbs of India to the Traditional Chinese Medicine (TCM) herbs in China, these plants have played pivotal roles in maintaining health and treating various ailments. They continue to be sources of inspiration for modern pharmaceutical research, contributing to the development of drugs and natural health products. Aromatic MAPs, on the other hand, tantalize the senses with their captivating scents and flavors. They are instrumental in the creation of perfumes, essential oils, and flavoring agents (Rajagopal et al., 2022). Aromatherapy, a holistic practice that utilizes the aromatic essences of plants for therapeutic purposes, draws extensively from the aromatic MAPs, promoting mental and emotional well-being. From an economic standpoint, the importance of high-value MAPs cannot be overstated. The global demand for these plants has driven a thriving market. Their cultivation and trade constitute a significant source of income for countless farmers and communities worldwide. The economic value is amplified by the fact that high-value MAPs often command premium prices due to their uniqueness and specialized applications. For example, saffron, derived from the *Crocus sativus* flower, is one of the world's most expensive spices, prized for its distinct flavor and color. Similarly, ginseng, a revered medicinal herb, is cultivated and traded at a premium. The essential oils extracted from aromatic MAPs, such as lavender and rosemary, are essential components in the fragrance and cosmetics industry, contributing to a multi-billion-dollar market. Moreover, the economic importance of high-value MAPs extends beyond primary cultivation and trade.

It encompasses value-added products like herbal supplements, cosmetics, and natural fragrances. These value-added products have become increasingly popular among health-conscious consumers seeking natural and sustainable alternatives. The current landscape of high-value MAPs reflects a rich tapestry of botanical diversity with profound economic implications. These plants, steeped in historical and cultural significance, continue to shape industries, livelihoods, and consumer choices.

High-value MAPs find their niches in diverse regions and climates across the globe. The suitability for cultivation is shaped by the specific species of MAPs and their environmental requirements. In the Mediterranean region, with its mild winters and hot summers, aromatic herbs like rosemary and oregano flourish. Meanwhile, tropical climates in countries like India and Brazil offer the perfect conditions for medicinal plants such as turmeric and neem, thriving in warm temperatures and abundant rainfall. In temperate regions of North America and Europe, MAPs like ginseng and echinacea find a home in well-defined seasonal changes. Desert climates host succulent plants like aloe vera, while high-altitude mountainous areas like the Himalayas cultivate herbs such as Himalayan rhubarb. Greenhouse cultivation is essential in extreme climates, and coastal regions offer moderate temperatures and humidity for plants like mint. Coastal areas in the Pacific Northwest provide optimal conditions for herbs like basil. Equatorial rainforests, with their high humidity and rainfall, nurture tropical MAPs in countries like Brazil and Peru. In essence, high-value MAPs demonstrate remarkable adaptability, thriving in a wide spectrum of environments, and contributing to local economies while preserving biodiversity and traditional knowledge.

A myriad of high-value MAPs are experiencing robust demand across diverse industries. Ginseng, renowned in traditional medicine, stands as a prized herb for enhancing well-being. Turmeric, with its potent anti-inflammatory properties, has surged in popularity in health supplements. Lavender, a fragrant favorite, thrives in perfumes and aromatherapy. Vanilla remains a ubiquitous flavor in the culinary world. Frankincense's aromatic resin finds its place in perfumes and traditional medicine. Saffron, among the world's costliest spices, adorns gourmet cuisine. Tea tree oil, treasured for its antimicrobial prowess, is a staple in skincare. Peppermint's refreshing aroma elevates food and beverages. Echinacea, celebrated for potential immune support, stars in herbal remedies. And rosemary, an aromatic herb, enriches both cuisine and cosmetics. These high-demand MAP species mirror the global inclination toward natural and health-conscious products (González-Minero et al., 2020), fostering their prominence in sectors ranging from healthcare to culinary purposes, cosmetics, and well-being.

III. EMERGING TRENDS IN HIGH-VALUE MAPS CULTIVATION

High-value MAPs are entering a new era of cultivation characterized by dynamic trends poised to redefine the industry. Firstly, sustainable, and organic cultivation practices are experiencing a surge in popularity. Responding to increasing environmental awareness and consumer demands for clean, pesticide-free products, growers are transitioning to methods that prioritize ecological stewardship, enrich soil health, and reduce chemical inputs. These practices not only resonate with eco-conscious consumers but also lay the foundation for long-term viability by preserving biodiversity and ecosystem integrity. Simultaneously, innovative cultivation techniques are revolutionizing the way high-value MAPs are grown.

Precision agriculture, hydroponics, and vertical farming are at the forefront, leveraging cutting-edge technology and data-driven approaches to optimize crop production (Nandi & Nithya, 2018). By fine-tuning environmental conditions and resource allocation, these techniques promise to boost yields, reduce resource consumption, and maintain consistent quality, all while addressing the challenges presented by changing climate patterns and market dynamics. Biotechnology emerges as a transformative force in high-value MAPs cultivation. Genetic modification and tissue culture techniques are being harnessed to enhance the traits of these plants, from bolstering resistance to pests and diseases to increasing yield and elevating the content of bioactive compounds. This biotechnological intervention holds immense promise in overcoming production hurdles, enhancing the commercial viability of MAPs, and ensuring product safety and quality. Furthermore, the adaptation of MAPs cultivation to changing climate conditions is paramount. The development of climate-resilient varieties and cultivation methods is a pressing need. This entails selecting or breeding plant varieties with heightened resilience to evolving climate patterns and adopting practices that mitigate climate-related risks. As climate change effects become more pronounced, this adaptation strategy is essential to secure the continued supply of these invaluable botanical resources. The emerging trends in high-value MAPs cultivation mark a proactive response to the evolving challenges and opportunities within the agricultural sector. They underscore the industry's commitment to environmental sustainability, technological innovation, and adaptability in the face of a shifting climate landscape. These trends collectively shape the future of high-value MAPs cultivation, emphasizing sustainability, innovation, and adaptability as the guiding principles for a resilient and prosperous industry.

IV. HIGH-VALUE MAPS IN PHARMACEUTICALS AND NUTRACEUTICALS

High-value MAPs stand as linchpins of modern healthcare, occupying pivotal roles in both pharmaceuticals and nutraceuticals, where their profound influence is rewriting the narrative of well-being. Within the pharmaceutical domain, MAPs are akin to nature's pharmacists, offering a treasure trove of bioactive compounds and potent remedies. Artemisinin, derived from *Artemisia annua*, embodies a watershed moment in the fight against malaria, while morphine from the opium poppy, *Papaver somniferum*, transformed pain management. Yet, their significance extends far beyond these examples, with countless MAPs contributing to drug discovery and development. These botanicals also serve as the living archives of millennia-old traditional healing systems, continually inspiring and informing modern pharmaceutical research. Simultaneously, in the dynamic arena of nutraceuticals, high-value MAPs are catalysts of a wellness revolution. Their phytochemical richness translates into potent health-enhancing agents. Garlic's cardiovascular benefits and ginkgo's support for cognitive function exemplify their roles as proactive health assets. The nutraceutical industry capitalizes on these attributes, offering natural, plant-based solutions to an increasingly health-conscious demographic. These products transcend supplements, becoming lifestyle choices, as consumers seek holistic, preventative health measures. The significance of high-value MAPs becomes resoundingly clear through case studies that underscore their tangible impact. Taxol's revolution in cancer treatment, saw palmetto's contribution to prostate health, and curcumin's ascent as an anti-inflammatory and antioxidant exemplar, are vivid testaments to their transformative potential. In pharmaceuticals and nutraceuticals, high-value MAPs occupy a pivotal space, where ancient wisdom meets cutting-edge science, creating a continuum of health and healing options that resonate deeply

with the ethos of modern wellness, reinforcing their indispensability in the journey toward optimal health and vitality.

V. HIGH-VALUE MAPS IN CULINARY AND GASTRONOMY

The convergence of high-value MAPs with the world of culinary purposes and gastronomy creates a symphony of flavors, aromas, and cultural heritage that transcends mere sustenance to elevate dining to an art form. These botanical gems, renowned for their exquisite aromatic profiles and distinctive flavors, hold a pivotal role in global cuisines. From the delicate floral notes of lavender enhancing French dishes to the bold, earthy richness of saffron in Middle Eastern cuisine, high-value MAPs infuse culinary creations with layers of complexity and depth. Their versatility spans sweet and savory applications, elevating desserts, beverages, soups, stews, and marinades alike. Beyond their flavor, these herbs and spices introduce texture, color, and visual appeal to culinary masterpieces, captivating not only the palate but also the eye. Yet, their influence extends beyond taste, encompassing the entire sensory experience. Essential oils extracted from aromatic herbs like rosemary and thyme waft through the air, invigorating the senses and etching unforgettable dining memories. The embrace of cinnamon and cloves' warmth or the zest of ginger and cardamom imbues dishes with an otherworldly quality, turning everyday meals into extraordinary gastronomic adventures. These botanical treasures are culinary alchemists, enchanting the essence of food and making every bite a journey into sensory delight. High-value MAPs are more than mere ingredients; they are cultural artifacts, weaving into the fabric of global culinary traditions. In the Mediterranean, the union of olive oil and aromatic herbs symbolizes a rich culinary heritage, while Indian cuisine's symphony of spices - turmeric, cumin, and coriander - is an integral part of its identity. Thai cuisine's harmonious blend of sweet, sour, spicy, and aromatic flavors relies on herbs like lemongrass, basil, and kaffir lime leaves. Mexican cuisine, known for its vibrant palette, embraces the fiery notes of chili peppers and the warmth of cumin and cinnamon. Across continents, high-value MAPs intertwine with the tapestry of cultural expression, showcasing their adaptability and cultural significance. They preserve age-old traditions while inspiring new culinary innovations. In the realm of culinary and gastronomy, high-value MAPs emerge as treasured ingredients, elevating dishes to a realm of sensory delight and cultural resonance. Their influence transcends borders, weaving a thread of botanical artistry into global culinary traditions, promising endless exploration and appreciation for the flavors and aromas they bestow upon our palates. High-value MAPs are not just culinary assets; they are culinary treasures.

VI. FUTURE PROSPECTS FOR HIGH-VALUE MAPS

The future of high-value Medicinal and Aromatic Plants (MAPs) unfolds with a tantalizing mix of challenges and opportunities that together shape the industry's path forward. On one hand, the sector grapples with concerns like sustainability, ethical sourcing, and the conservation of wild populations. Striking a balance between economic interests and the preservation of biodiversity and cultural heritage remains pivotal. However, these very challenges become fertile grounds for innovation, inspiring the development of eco-friendly cultivation, harvesting, and processing practices. The global stage welcomes high-value MAPs with open arms as consumer preferences shift towards natural and plant-based products. A rising demand for wellness, natural remedies, and clean-label offerings propels MAPs into the spotlight. This burgeoning global demand not only promises economic growth

but also opens doors for cultivation expansion, international trade, and the creation of value-added products that cater to the evolving needs of consumers. In the realm of research and innovation, high-value MAPs are a trove of untapped potential. Their intricate chemical profiles and historical uses beckon to scientists and innovators. Within this realm, the possibilities are boundless - from unlocking new therapeutic applications to discovering novel bioactive compounds and harnessing biotechnological advancements for crop improvement. High-value MAPs continue to play vital roles in ensuring food security, supporting health, and championing sustainability. These diverse botanical resources enrich dietary diversity, enhancing food security in an ever-changing world. They inspire drug discovery, contributing to health and well-being. Moreover, the cultivation of MAPs, when approached sustainably, acts as a safeguard for natural habitats, protecting biodiversity and promoting ecological harmony. Sustainability remains the guiding principle for the future of high-value MAPs. Practices like agroforestry, organic farming, and habitat conservation are paramount to ensure the longevity of these invaluable resources. Biodiversity-friendly approaches underscore the industry's commitment to preserving the delicate balance of ecosystems, ensuring that future generations can continue to reap the benefits of these remarkable botanical treasures. As high-value MAPs navigate the road ahead, they find themselves at the intersection of challenges and opportunities. The industry's trajectory will be determined by its ability to harmonize economic interests with ecological and cultural responsibilities, adapt to evolving market dynamics, advance scientific exploration, contribute to health and well-being, and unwaveringly champion sustainability as the guiding beacon towards a prosperous and harmonious future.

VII. CONCLUSION

In conclusion, this chapter has provided a comprehensive exploration of the future prospects and trends in high-value Medicinal and Aromatic Plants (MAPs). These remarkable plants hold immense significance across various dimensions, including health and well-being, economy, culture, sustainability, and environmental conservation. As we look ahead, it is evident that MAPs will play a pivotal role in shaping our future. They will continue to be a source of innovation, driving sustainability in cultivation and harvesting practices while minimizing environmental impact. The economic viability of MAPs will be closely linked to aligning production with evolving market demands and consumer preferences. In the realm of health and well-being, the potential of MAPs remains vast, with ongoing discoveries of new health applications and therapeutic uses. These plants are poised to contribute to the development of wellness products and healthcare solutions that harness their full potential. In essence, exploring the future of high-value MAPs is not only a matter of anticipation but also responsible stewardship. It ensures that these plants continue to enrich our lives, contributing to health, culture, economy, and environmental harmony in the years to come. As we embark on this journey into the future of MAPs, we are presented with opportunities to harness their full potential and create a more sustainable and vibrant world.

VIII. ACKNOWLEDGMENT

We extend our heartfelt thanks to the researchers, authors, colleagues, and publishing teams who contributed to this chapter on MAPs. We would like to express our gratitude to Elsevier, Springer, books, and websites from which data and information were collected during the writing of this book chapter.

Table 1: High-value Medicinal and Aromatic Plants (MAPs)

Plant Species	Common Uses	Geographic Region	Economic Importance	Reference
Lavandula angustifolia	Aromatherapy, essential oils	Mediterranean, Europe	High: Essential oils, Perfumes	(Pokajewicz et al., 2021)
Panax ginseng	Traditional medicine, supplements	Asia, North America	High: Herbal supplements	(Jin et al., 2019)
Rosa damascena	Perfumery, rose water	Middle East, Bulgaria	High: Perfume industry	(Chroho et al., 2022)
Mentha piperita	Culinary, aromatherapy	Worldwide	High: Culinary, essential oils	(Heydari et al., 2018)
Curcuma longa	Spice, medicinal	South Asia	High: Spice, curcumin extract	(Sabir et al., 2021)
Artemisia annua	Malaria treatment, herbal remedies	Worldwide	High: Antimalarial drug	(Septembre-Malaterre et al., 2020)
Pelargonium graveolens	Aromatherapy, essential oils	South Africa	High: Essential oils, perfumes	(Al-Mijalli et al., 2022)
Origanum vulgare	Culinary, medicinal	Mediterranean, worldwide	High: Culinary, essential oils	(Lombrea et al., 2020)
Valeriana officinalis	Herbal medicine, supplements	Europe, Asia	High: Herbal supplements	(Sánchez et al., 2021)

Geographic Region	Suitable Climates	Examples of High-value MAPs	Reference
Mediterranean	Mediterranean, Subtropical	Lavender, Rosemary, Thyme, Sage	(Choi et al., 2022)
South Asia	Tropical, Subtropical	Turmeric, Cardamom, Cinnamon, Cloves	(Mardiah et al., 2019)
Middle East	Arid, Semi-Arid	Saffron, Rose, Frankincense, Myrrh	(Zohar & Lev, 2013)
South America	Tropical, Subtropical	Vanilla, Cocoa, Copaiba, Ylang-Ylang	(López-Juárez et al., 2019)
Europe	Temperate	Chamomile, Valerian, Calendula, Echinacea	(Ernst, 2010)
North America	Temperate	Echinacea, Goldenseal, Peppermint, Yarrow	(Awang, 2011)
Southeast Asia	Tropical, Subtropical	Lemongrass, Basil, Kaffir Lime, Pandan	(Aiemsaard et al., 2021)
Africa (Various Regions)	Varied Climates	Rooibos, Baobab, Myrrh, Frankincense	(Research, 2002)
Oceania (Australia)	Temperate, Subtropical	Tea Tree, Eucalyptus, Sandalwood, Macadamia	(Warnke et al., 2009)

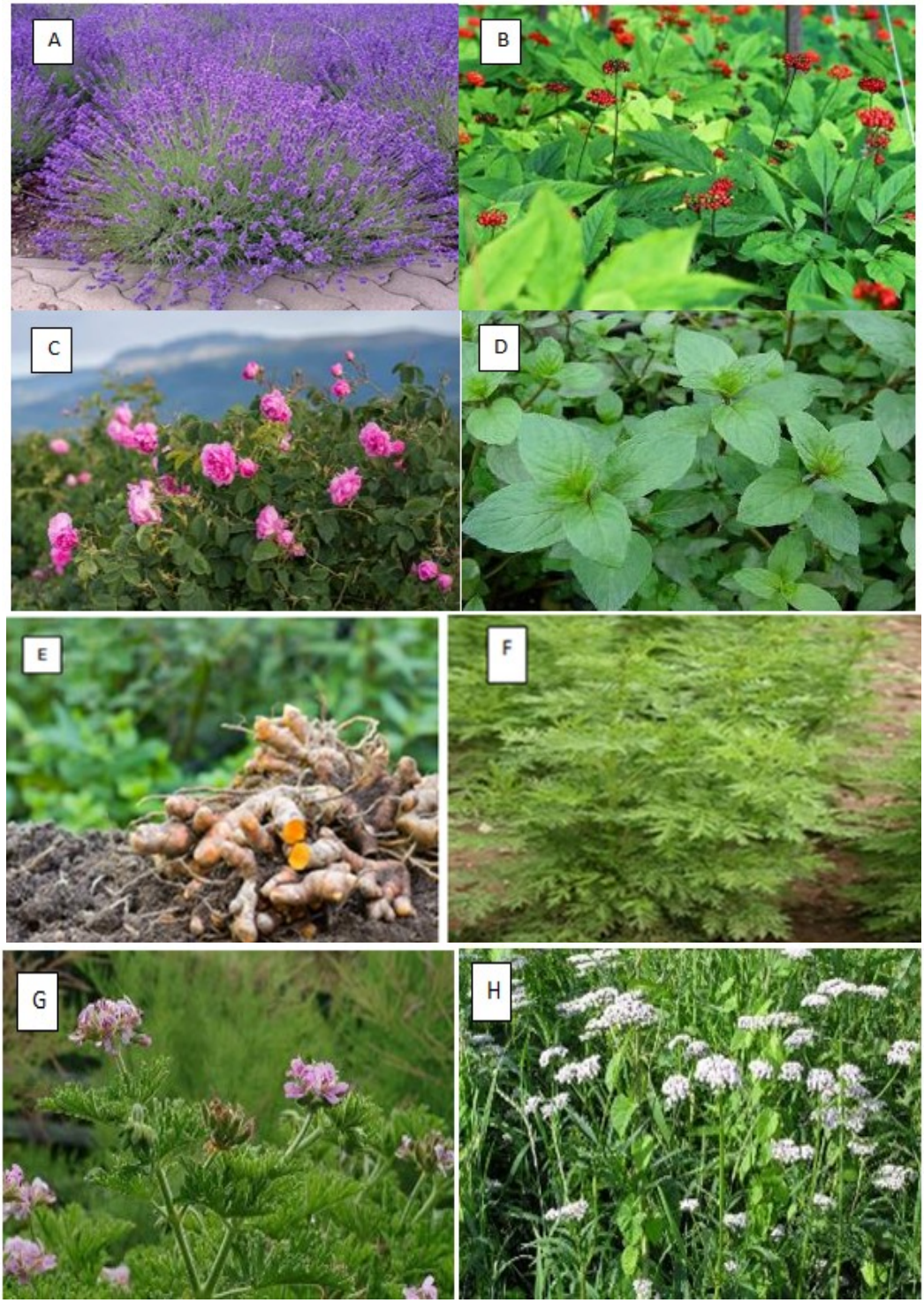

Figure 1: Images of important medicinal and aromatic plants integral to pharmaceutical, cosmetic, aromatic, culinary, and traditional medicinal practices; **[A]** Lavender (*Lavandula angustifolia*); **[B]** Man-root (*Panax ginseng*); **[C]** Damask Rose (*Rosa damascena*); **[D]** Peppermint (*Mentha piperita*); **[E]** Turmeric (*Curcuma longa*); **[F]** Artemisia (*Artemisia annua*); **[G]** Geranium (*Pelargonium graveolens*); **[H]** Valeriana (*Valeriana officinalis*)

REFERENCES

[1] Aiemsaard, J., Jarassaeng, C., & Thongkham, E. (2021). The Effect of Some Essential Oils Against Subclinical Mastitis Bacteria Isolated from Dairy Goats. Chiang Mai University Journal of Natural Sciences, 20(1). https://doi.org/10.12982/CMUJNS.2021.009

[2] Al-Mijalli, S. H., Mrabti, H. N., Assaggaf, H., Attar, A. A., Hamed, M., Baaboua, A. E. L., Omari, N. El, Menyiy, N. El, Hazzoumi, Z., Sheikh, R. A., Zengin, G., Sut, S., Dall'Acqua, S., & Bouyahya, A. (2022). Chemical Profiling and Biological Activities of Pelargonium graveolens Essential Oils at Three Different Phenological Stages. Plants, 11(17). https://doi.org/10.3390/plants11172226

[3] Awang, D. (2011). Mosby's Handbook of Herbs and Natural Supplements. Focus on Alternative and Complementary Therapies, 16(4). https://doi.org/10.1111/j.2042-7166.2011.01102.x

[4] Bargali, H., Kumar, A., & Singh, P. (2022). Plant studies in Uttarakhand, Western Himalaya–A comprehensive review. Trees, Forests and People, 8. https://doi.org/10.1016/j.tfp.2022.100203

[5] Chaachouay, N., Benkhnigue, O., Fadli, M., El Ayadi, R., & Zidane, L. (2019). Ethnopharmacological studies of medicinal and aromatic plants used in the treatment of respiratory system disorders in the Rif, Morocco. Ethnobotany Research and Applications, 18. https://doi.org/10.32859/ERA.18.22.1-17

[6] Choi, N. Y., Wu, Y. T., & Park, S. A. (2022). Effects of Olfactory Stimulation with Aroma Oils on Psychophysiological Responses of Female Adults. International Journal of Environmental Research and Public Health, 19(9). https://doi.org/10.3390/ijerph19095196

[7] Chroho, M., Bouymajane, A., Oulad El Majdoub, Y., Cacciola, F., Mondello, L., Aazza, M., Zair, T., & Bouissane, L. (2022). Phenolic Composition, Antioxidant and Antibacterial Activities of Extract from Flowers of Rosa damascena from Morocco. Separations, 9(9). https://doi.org/10.3390/separations9090247

[8] Ernst, E. (2010). Mosby's Handbook of Herbs and Supplements and their Therapeutic Uses. Focus on Alternative and Complementary Therapies, 8(2). https://doi.org/10.1111/j.2042-7166.2003.tb03767.x

[9] González-Minero, F. J., Bravo-Díaz, L., & Ayala-Gómez, A. (2020). Rosmarinus officinalis L. (Rosemary): An Ancient Plant with Uses in Personal Healthcare and Cosmetics. Cosmetics, 7(4). https://doi.org/10.3390/cosmetics7040077

[10] Heydari, M., Zanfardino, A., Taleei, A., Bushehri, A. A. S., Hadian, J., Maresca, V., Sorbo, S., Napoli, M. Di, Varcamonti, M., Basile, A., & Rigano, D. (2018). Effect of heat stress on yield, monoterpene content and antibacterial activity of essential oils of mentha x piperita var. mitcham and mentha arvensis var. piperascens. Molecules, 23(8). https://doi.org/10.3390/molecules23081903

[11] Jin, Y., Cui, R., Zhao, L., Fan, J., & Li, B. (2019). Mechanisms of Panax ginseng action as an antidepressant. In Cell Proliferation (Vol. 52, Issue 6). https://doi.org/10.1111/cpr.12696

[12] Kalita, J., & Khan, M. L. (2013). Medicinal plants from the high altitudes of the western part of Arunachal Pradesh, India and their trade. International Journal of Conservation Science, 4(3).

[13] Lombrea, A., Antal, D., Ardelean, F., Avram, S., Pavel, I. Z., Vlaia, L., Mut, A. M., Diaconeasa, Z., Dehelean, C. A., Soica, C., & Danciu, C. (2020). A recent insight regarding the phytochemistry and bioactivity of origanum vulgare l. Essential oil. In International Journal of Molecular Sciences (Vol. 21, Issue 24). https://doi.org/10.3390/ijms21249653

[14] López-Juárez, S. A., Hipólito-Romero, E., Cerdán-Cabrera, C. R., Ortiz-Ceballos, G. C., & Reyes-López, D. (2019). Association between cocoa (Theobroma cacao L.) and vanilla (Vanilla planifolia Jacks. ex Andrews) crops in an agroforestry system in Comalcalco, Tabasco]. Tropical and Subtropical Agroecosystems, 22(3).

[15] Mardiah, Noor, R., Suprayatmi, M., & Listianti, E. (2019). Minuman Fungsional Ready To Drink Berbahan Baku Rempah Lokal. Jurnal Pangan Halal Volume, 1(2).

[16] Mathela, M., Kumar, A., Sharma, M., & Goraya, G. S. (2021). Hue and cry for Fritillaria cirrhosa D.Don, a threatened medicinal plant in the Western Himalaya. Discover Sustainability, 2(1). https://doi.org/10.1007/s43621-021-00048-5

[17] Nandi, R., & Nithya, V. G. (2018). Organic mango value chains and determinants of market linkage: a smallholder's perspective for inclusive growth. Green Farming, 9(5).

[18] Nazim, M., Sadiq, Q.-U.-A., Nawaz, A., Anjum, S., Ali, M., & Maryam, H. (2020). Mentha arvensis, a medicinal and aromatic plant, has high nutritional value and several-uses: A review. Buletin Agroteknologi, 1(2). https://doi.org/10.32663/ba.v1i2.1180

[19] Pokajewicz, K., Białoń, M., Svydenko, L., Fedin, R., & Hudz, N. (2021). Chemical composition of the essential oil of the new cultivars of lavandula angustifolia mill. Bred in ukraine. Molecules, 26(18). https://doi.org/10.3390/molecules26185681

[20] Rajagopal, V., Shanmugam, P. V., & Nandre, R. (2022). Quantifying reputation risk using a fuzzy cognitive map: a case of a pharmaceutical supply chain. Journal of Advances in Management Research, 19(1). https://doi.org/10.1108/JAMR-08-2020-0203
[21] Research, F. (2002). African Natural Plant Products: Technology, February.
[22] Rubab, L., Afroz, S., Ahmad, S., Hussain, S., Nawaz, I., Irfan, A., Batool, F., Kotwica-Mojzych, K., & Mojzych, M. (2022). An Update on Synthesis of Coumarin Sulfonamides as Enzyme Inhibitors and Anticancer Agents. In Molecules (Vol. 27, Issue 5). https://doi.org/10.3390/molecules27051604
[23] Sabir, S. M., Zeb, A., Mahmood, M., Abbas, S. R., Ahmad, Z., & Iqbal, N. (2021). Phytochemical analysis and biological activities of ethanolic extract of curcuma longa rhizome. Brazilian Journal of Biology, 81(3). https://doi.org/10.1590/1519-6984.230628
[24] Sánchez, M., Burgos, E. G., Iglesias, I., & Pilar Gómez-Serranillos, M. (2021). Updating the biological interest of valeriana officinalis. Mediterranean Botany, 42. https://doi.org/10.5209/MBOT.70280
[25] Schuhmacher, A., Brieke, C., Gassmann, O., Hinder, M., & Hartl, D. (2021). Systematic risk identification and assessment using a new risk map in pharmaceutical R&D. In Drug Discovery Today (Vol. 26, Issue 12). https://doi.org/10.1016/j.drudis.2021.06.015
[26] Septembre-Malaterre, A., Rakoto, M. L., Marodon, C., Bedoui, Y., Nakab, J., Simon, E., Hoarau, L., Savriama, S., Strasberg, D., Guiraud, P., Selambarom, J., & Gasque, P. (2020). Artemisia annua, a traditional plant brought to light. In International Journal of Molecular Sciences (Vol. 21, Issue 14). https://doi.org/10.3390/ijms21144986
[27] Shukla, S. K., Sharma, L., Jaiswal, V. P., Dwivedi, A. P., Yadav, S. K., & Pathak, A. D. (2022). Diversification Options in Sugarcane-Based Cropping Systems for Doubling Farmers' Income in Subtropical India. Sugar Tech, 24(4). https://doi.org/10.1007/s12355-022-01127-1
[28] Ur-Rahman, I., Sher, H., & ... (2019). Reference guide on high value medicinal and Aromatic plants–sustainable management and cultivation practices. In University of Swat, Pakistan.
[29] Warnke, P. H., Becker, S. T., Podschun, R., Sivananthan, S., Springer, I. N., Russo, P. A. J., Wiltfang, J., Fickenscher, H., & Sherry, E. (2009). The battle against multi-resistant strains: Renaissance of antimicrobial essential oils as a promising force to fight hospital-acquired infections. Journal of Cranio-Maxillofacial Surgery, 37(7). https://doi.org/10.1016/j.jcms.2009.03.017
[30] Zhong, H., Chan, G., Hu, Y., Hu, H., & Ouyang, D. (2018). A comprehensive map of FDA-approved pharmaceutical products. In Pharmaceutics (Vol. 10, Issue 4). https://doi.org/10.3390/pharmaceutics10040263
[31] Zohar, A., & Lev, E. (2013). Trends in the use of perfumes and incense in the near east after the muslim conquests. Journal of the Royal Asiatic Society, 23(1). https://doi.org/10.1017/S1356186312000673

