

CHAPTER

9

HERBAL NANOTECHNOLOGY ADVANCEMENT

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9.1 HERBAL NANOTECHNOLOGY

Herbal nanotechnology is an emerging interdisciplinary field which aims to integrate the therapeutic properties of medicinal plants with the advanced nanotechnology. This integration overcomes the inherent limitations such as poor solubility, low bioavailability and instability of herbal medicines. Herbal medicines in the form of nanomaterials would improve their delivery and effectiveness. Therefore, herbal nanotechnology would enhance the efficacy of natural compounds extracted from herbs.

Figure 9.1 indicates the worldwide market of herbal products which is expected to increase at a compound annual growth rate (CAGR) of about 11.2% over the period of 2022 to 2028. The market for herbal products is expected to grow to MYR1,634 billion by 2028. Pharmaceuticals generated the most revenue according to the application segmentation in 2021 (Zion Market Research, 2022). Due to the increasing demand for herbal materials to manufacture supplements, the worldwide market is anticipated to generate the highest revenue from the pharmaceutical and nutraceutical market in coming years.

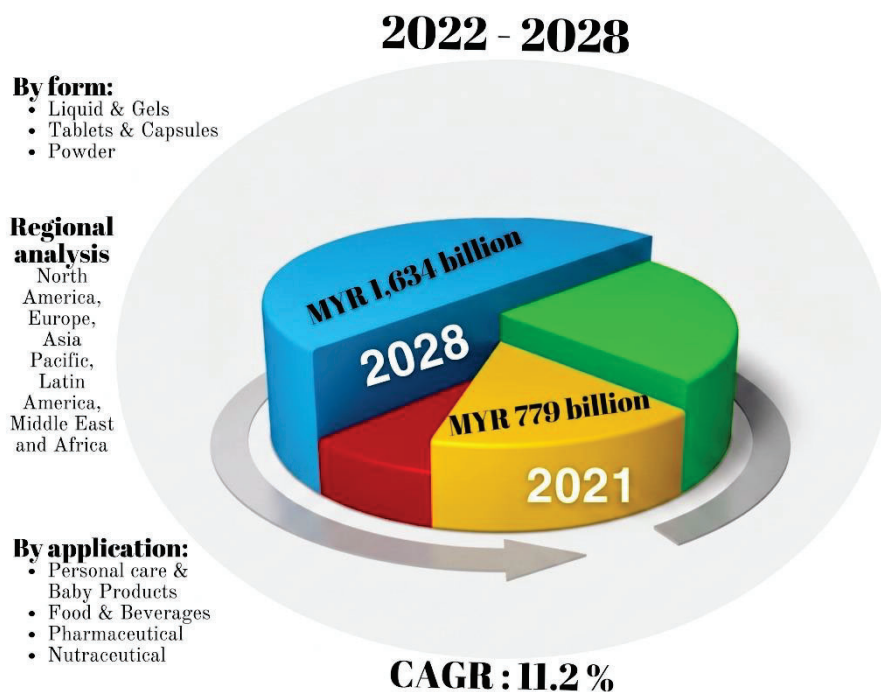


Figure 9.1 Market analysis for herbal-based products

Nanoparticles (NPs) such as metal NPs, liposomes, and polymeric NPs are commonly used in herbal nanotechnology to encapsulate and deliver plant based bioactive compounds. These nano-formulations enhance the solubility, stability, and bioavailability of herbal extracts. For instance, curcumin which is a lipophilic compound derived from turmeric, shows significantly improved solubility and therapeutic efficacy when it is encapsulated in NPs. The encapsulated curcumin offered more effective treatment for cancer and inflammatory diseases (Witika et al., 2021). Similarly, quercetin which is a flavonoid known for its antioxidant properties, could exhibit enhanced stability and biological activity when it was delivered as nanoencapsules (Chen et al., 2020). Although initial studies indicate that herbal NPs are generally safe, comprehensive toxicological assessments are necessary to ensure their safety for human use. Meanwhile, innovative solutions are strongly

required as large-scale production and standardization of herbal NPs still presents significant technical and regulatory challenges.

9.2 STRATEGIES FOR DEVELOPING PLANT DERIVED NANOPARTICLES

The advancement of nanotechnology has significantly ushered in innovations across various fields such as medicine, agriculture, and environmental science. Plant-derived NPs have emerged as a focal point of research due to their eco-friendly synthesis processes and potential health benefits. The use of plant extracts in the synthesis of NPs offers a sustainable alternative to conventional chemical methods. The utilization of natural phytochemicals reduces the application of metal ions in the NPs development and formulation.

Various strategies have been developed to formulate NPs with different properties of herbal extracts. Key parameters such as temperature, pressure, agitation speed, aqueous to organic phase ratio and concentration of herbal extracts must be critically considered because the parameters significantly influence the size and stability of NPs. Table 9.1 summarizes some examples of NPs formulation strategies. The examples clearly demonstrate that plant derived NPs can be developed under different processing variables depending upon the nature of herbal extracts. Previous nano-formulation strategies produced different particle sizes, and encapsulation efficiencies. Biodegradable polymer-based nanoparticles such as curcumin-loaded PCL/PLGA and neem-loaded zein nanoparticles, generally produced small particle sizes below 150 nm. Neem and lavender oil formulations showed notably high encapsulation efficiency up to 80%. Metal-based nanoparticles formulated with plant extracts such as holy basil-loaded iron nanoparticles and licorice-loaded silver nanoparticles demonstrated nanoscale dimensions along with distinct surface properties, including zeta potential, elongation, and wettability. All the findings of previous investigators demonstrated that variations in formulation composition