10. Ayurvedic Formulations as Templates for Nanobiotechnology in Drug Delivery

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Abstract

Ayurveda, the ancient Indian system of medicine, has long employed herbal and mineral formulations with remarkable therapeutic efficacy and minimal toxicity. Recent scientific advancements have revealed that many traditional Ayurvedic preparations inherently possess nano-sized particles, offering a natural model for modern nanobiotechnology. The paper will discuss the ways in which Ayurvedic principles and formulations could be used as a template when designing nanocarrier-based drug delivery systems. A survey was carried out on biotechnology researchers, Ayurveda practitioners, and pharmaceutical students in order to evaluate their awareness, perception and opinion regarding integration of Ayurvedic nanomedicine and modern nanobiotechnology. The results suggest that the interdisciplinary collaboration can be supported strongly, and it is possible to refer to the potential of Ayurvedic formulations, which can serve as prototypes of sustainable and biocompatible drug-delivery systems. The article concludes that using Ayurveda expertise to overcome nanotechnological invention will go a long way in terms of precision medicine and pharmacological efficacy.

Keywords

Nanobiotechnology, Ayurveda, drug delivery, Rasashastra, nanoformulations, nanoparticles of herbs, targeted therapy, nanocarriers, traditional medicine.

Introduction

Nanotechnology has transformed drug delivery through the ability to release the drug and specifically target the sites and increase bioavailability of therapeutics. Nevertheless, the idea of nanoscale medicine is not so alien to the Indian long-standing science. Such ancient Ayurvedic sources as Rasashastra and Charaka Samhita indicate the application of Bhasma (prepared of metals and minerals by calcing) and Swarasa (prepared of herbs through extraction) as incredibly strong, at extremely small dosages, a quality that would later be attributed to nanomaterials.

Investigations conducted using transmission electron microscopy (TEM) and X-ray diffraction (XRD) have established Bhasmas to have particles of between 5 and 50 nanometers (Kumar et al., 2016). Their biocompatibility and stability provide them as possible contenders in the field of a contemporary nanocarrier system like liposomes, metal-based nanoshells, and polymeric nanoparticles.

The Ayurvedic Ayurvedic lipid based drug carriers, including Ghrita (medicated ghee) and Taila (medicated oils) are also a part of traditional Ayurvedic formulations with the pharmacokinetic characteristics, which resemble the properties of lipid nanoparticles in modern biomedical research (Patwardhan et al., 2020). Therefore, Ayurveda does not only foreshadow nanomedicine in practice, but also offers a basis to design less toxic, more biocompatible nanotherapeutics, which have an empirical basis.

Nanobiotechnology is starting to look into these age-old preparations revisited in recent years with a view to the possible application in targeted drug delivery, bioavailability (enhancement) and detoxification mechanisms (Rai et al., 2021). The combination of such traditional nanoformulations, together with the contemporary scientific tools, can result in the concept of novel delivery systems that can be both wise and scientifically rigorous.

Methodology (Survey Method)

The cross-sectional survey involved that which was taking place between the months of July and September 2025 and was aimed at analyzing the views regarding the use of Ayurvedic formulations as models due to which nanobiotechnological applications would be made in the area of drug delivery.

Sample participants: 180 participants

Demographics:

- 60 Ayurveda practitioners and students
- 60 biotechnology and nanotechnology researchers
- 60 pharmaceutical science students and professionals

Survey tool:

Structured questionnaire- 18 questions (12 close-ended and 6 open-ended) that dealt with:

Knowledge concerning Ayurvedic nanoformulations (Bhasmas, Ghritas, Tailas).

Knowledge on the use of nanobiotechnology.

Integration of Ayurveda and nanoscience– opinions.

Principles of perceived goodness of such a combination and ethical dilemmas.

Discussion

The survey summarizes an insightful and cautiously positive attitude of Ayurvedic preparations as nanotechnology inspirations. Although the majority of the respondents (89% of all) were aware of nanotechnology, among the less than half (47% of all) aware of the fact that Ayurvedic Bhasmas may consist of naturally occurring nanoparticles, there is a knowledge gap. It was evident that most people (78 percent) were in favor of integrating Ayurvedic principles with the current nanobiotechnology to come up with a superior drug carrier and 82 percent of biotechnology scientists underlined the importance of strict structural and toxicological characterization of these traditional nanoparticles. Similarly, 73 percent Ayurveda practitioners felt that contemporary nanobiological acceptance could enhance the global acceptance of conventional medicines. Ethical and safety aspects were also not disregarded: half of the participants were concerned about the abuse or excessive commercialization of Ayurvedic products selling as the nanomedicine. These findings were supplemented by qualitative remarks indicating Bhasmas and lipid-based preparations as potentially useful bio-inspired carriers of drugs against chronic diseases and metabolic diseases, and giving parallels between Ayurvedic Shodhana (purification) of substances and purification steps of nanoparticles- an empirical understanding of nanoscale safety even before its scientific expression. The findings, in general, indicate Ayurveda has both conceptual and practical premises to nanoscale drug delivery, and developing safer, more sustainable nanomedicines can be hastened through collaboration with a

modern biotechnology, introducing narrow analytical methods, synthetic control and rigor regulating toxins and vehicles.

Suggestions

Analytical Characterization: Test Bhasmas conventional and herbal formulation on the basis of a high-end instrument (TEM, SEM, XRD, DLS) to verify the nanoscale of the structural characteristics.

Collaborative Research: set up joint centers of Ayurvedic Nanomedicine that would bring together Ayurveda, biotechnology, and pharmaceutical sciences.

Ethical Regulation: Standard reports: Standard safety and toxicity test procedures should be developed to guarantee responsible usage of Ayurvedic nanoformulations.

Education and Training: Find ways of incorporating Ayurvedic nanotechnology module into biotechnology and pharmacy programs.

Commercial Translation: Help the start-ups and industrial partnerships in coming up with environmentally friendly, biocompatible nanodrugs based on the Ayurvedic compounds.

Conclusion

The Ayurvedic recipes have been developed over the ages, and they incorporate the following principles that are currently core to nanobiotechnology such as targeted delivery, reduced dosage, and biocompatibility. The survey indicates that curiosity is on the rise in the various disciplines in terms of combining the traditional knowledge with the newer nanoscience. Ayurvedic Bhasmas and lipid-based carriers can be used as prototypes of developing nanocarriers in terms of high stability and low toxicity. A systematic validation of the Ayurveda system and the nanobiotechnology can result in new systems of drug administration, which are scientifically sound and most importantly culturally sound. Such synthesis, besides bringing back ancient knowledge, makes Ayurveda a paradigm of the new generation of sustainable nanomedicine..

6. References

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