Analytical and Bioanalytical Chemistry
https://doi.org/10.1007/s00216-024-05543-y

EDITORIAL

Introduction to nanozymes

Vipul Bansal[1] · Sudipta Seal[2] · Hui Wei[3]

Nanozymes are functional nanomaterials with enzyme-like characteristics [1]. They have started to firmly establish themselves as next-generation artificial enzymes because of certain advantages over enzymes and conventional enzyme mimics. Notably, nanozymes were selected as one of the 2022 Top Ten Emerging Technologies in Chemistry by the International Union of Pure and Applied Chemistry (IUPAC). Excitingly, nanozymes have shown great promise in analysis due to their high stability, low cost, and tunable activity. Nanozymes have been employed to detect bioactive small molecules, biomacromolecules, exosomes, cells, bacteria, and viruses, enabling both in vitro diagnosis and in vivo bioanalysis. With the rapid development of the field, analytical kits and devices are anticipated for practical applications. This Topical Collection (*Nanozymes*) highlights the substantial progress achieved in employing nanozymes for analytical and bioanalytical chemistry.

For this collection, nearly 70% of the publications are original studies (Fig. 1A). Most of these studies employed redox nanozymes while two studies used hydrolase-like nanozymes (including one with phosphatase-like nanozymes). Among the redox nanozymes, peroxidase-like nanozymes were used most, followed by oxidase- and catalase-like nanozymes (Fig. 1B). Except for one mechanistic study, all the others were focused on analysis, covering targets from glucose to other bioactive small molecules to enzymes (Fig. 1C). Clearly, glucose was the mostly studied target. As shown in Fig. 1D, colorimetric, electrochemical, and fluorescent methods have been used in developing nanozyme assays, reflecting upon a range of transducer platforms in which nanozymes can be utilized. Among them, colorimetric detection is dominant, indicating a preference for simple, accessible, and cost-effective analytical techniques. Notably, colorimetric detection can be enhanced by using smartphones.

Various articles highlight the future challenges and opportunities in this field and an urgent need for computational design in nanozyme development. The substantial amount of data emerging from nanozyme research requires careful consideration of the application of AI and machine learning of data analytics to advance future research. While noting that most of the studies in the current collection focus on solution-based analytical approaches, another area in which nanozymes offer substantial potential is through their integration with field-deployable point-of-care devices—an area that has just started to emerge [2].

Published in the topical collection featuring *Nanozymes* with guest editors Vipul Bansal, Sudipta Seal, and Hui Wei.

✉ Hui Wei
weihui@nju.edu.cn

Vipul Bansal
vipul.bansal@rmit.edu.au

Sudipta Seal
sudipta.seal@ucf.edu

1 RMIT University, Melbourne, Australia

2 University of Central Florida, Orlando, USA

3 Nanjing University, Nanjing, China

Published online: 21 September 2024

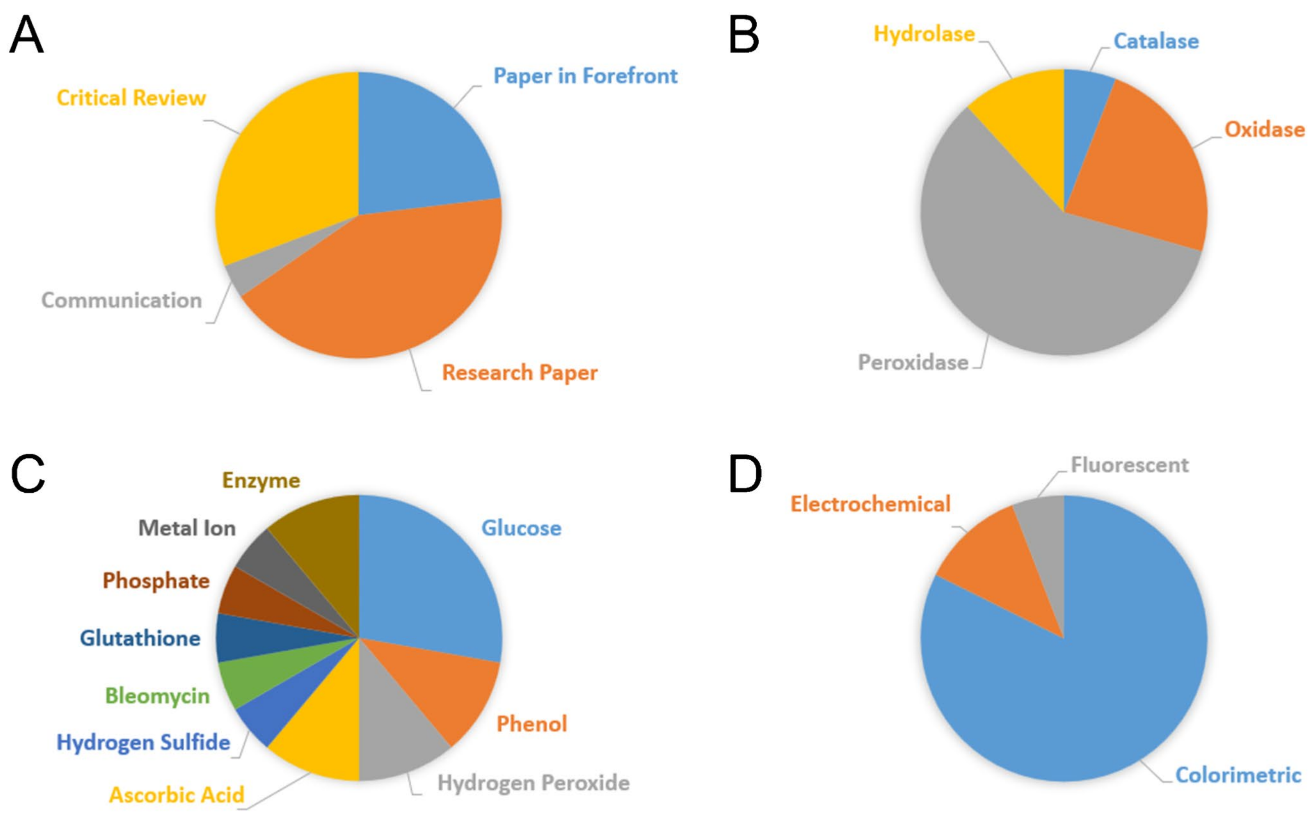

Fig. 1 Analysis of the Topical Collection: *Nanozymes*. **A** Types of publications. **B** Enzyme-like activities mimicked by nanozymes in research articles. **C** Targets detected by nanozymes. **D** Detection methods

With over 28 articles accepted to date, the interest attracted by this collection has far exceeded our expectations. We thank the authors for their great support and interest in this initiative and congratulate them for the high quality of their work. We thank the reviewers and journal editors for their time and support for this collection.

References

1. Wei H, Wang E. Chem Soc Rev. 2013;42:6060–93.
2. Baranwal A, Shukla R, Bansal V. TrAC. Trends Anal Chem. 2024;172:117573.

Vipul Bansal Fellow of the Royal Society of Chemistry, is Founding Director of the Sir Ian Potter NanoBioSensing Facility at RMIT University, Australia. After receiving his PhD in 2007 from the National Chemical Laboratory India, his independent career in Australia focused on understanding the complexities of nano-bio interactions. The ongoing learnings from this fundamental research have defined his current focus on the translation of biotechnologies and nanotechnologies from the bench-side to the bedside. His team employs nanozymes for analytical and diagnostic applications.

Hui Wei is Professor at Nanjing University and Fellow of the Royal Society of Chemistry. He received his BS degree from Nanjing University (advisor: Professor Xinghua Xia) and PhD degree from the Changchun Institute of Applied Chemistry, Chinese Academy of Sciences (advisor: Professor Erkang Wang). He then joined Professors Yi Lu and Shuming Nie's groups for two postdoctoral trainings before he started his independent career at Nanjing University. His research interests are focused on the design and synthesis of functional nanomaterials (such as nanozymes) and the development of new methodologies for analytical and biomedical applications.

Sudipta Seal Fellow of the American Society of Materials (FASM), University-Distinguished Professor, UCF Trustee Chair Professorship, and UCF Pegasus Professor, joined the University of Central Florida (UCF) in 1997 after postdoctoral work at Lawrence Berkeley National Laboratory, University of California, Berkeley. He served as Director of the Advanced Materials Processing Analysis Center, and Nanotechnology Center, is currently Chair of Materials Science and Engineering, and holds an appointment with the College of Medicine. His research interests include the design of surface-modified rare-earth oxide nanomaterials as nanozymes for catalysis and biomedical applications.