inorganics

MDPI

Editorial

Boron Applications in Prevention, Diagnosis and Therapy for High Global Burden Diseases

Marvin A. Soriano-Ursúa

Academia de Fisiología y Sección de Estudios de Posgrado e Investigación, Escuela Superior de Medicina del Instituto Politécnico Nacional, Plan de San Luis y Diaz Mirón s/n., Alc. Miguel Hidalgo, Mexico City 11340, Mexico; msoriano@ipn.mx

The role of boron-containing compounds (BCCs) in medicine is growing. BCCs have been well-known as bioactive agents in some infections and cancer; in this century, their applications are expanding remarkably. Successful efforts have yielded data suggesting the identification and development of new BCCs for the prevention, diagnosis, and treatment of high-global-burden diseases [1]. Among these maladies, identified as leading causes of global disability-adjusted life-years, cardiovascular diseases, cancer, neurodegeneration, metabolic disorders, and infectious chronic diseases are included. Non-communicable diseases particularly affect people older than 50 years [1]. BCC have also been described as agents to limit the risk factors related to these diseases (such as high body mass index or high fasting plasma glucose) [2].

Hence, this Special Issue, entitled "Synthesis and innovative biological activity of boron-containing compounds", is just a sample of recent advances in the field around the world.

Thus, Bita et al. reported the synthesis of a complex previously observed in nature, the diester chlorogenoborate complex. It has potential applications as a prebiotic in gut and oral health, and as a micronutrient essential for microbiota in humans and animals [3], which could be important for the prevention of some chronic diseases [4,5].

The synthesis of new compounds allows one to produce and study specific BCCs with the ability to interact with specific targets [6]. In this sense, Guseva et al. reported new boron-dipyrromethene (BODIPY) myrtenol derivatives with the potential to interact with and label compounds in the cell walls of bacteria and fungi [7]. Those, like other BODIPY complexes, could be applied for the prevention, diagnosis, and treatment of some infective diseases [8].

Synthetic BCCs have attracted attention due to their actions on cancer. In fact, BCCs have been studied as agents in boron neutron capture therapy, and some boron-containing peptides (like bortezomib) are active in multiple myeloma [9]. However, innovative mechanisms have been proposed or probed in multiple cancer cells. In this regard, Ortiz-Flores et al. carried out the identification of BCCs active on triple-negative breast cancer cells; they demonstrated that phenanthren-9-yl boronic acid and 6-hydroxynaphthalen-2-yl boronic acid have cytotoxic properties at sub-micromolar concentrations; however, the establishment of the mechanism of action requires additional evaluation [10]. Meanwhile, Oguzcan et al. reported borenium and borinium derivatives as safe compounds in healthy human cells, but with moderate action against glioblastoma, neuroblastoma, prostate, and pharyngeal cancer cell lines [11].

On the other hand, BCCs have recently been explored as active in neurons, mainly for the prevention and treatment of neurodegenerative diseases [12]. Interestingly, Morocz et al. reported phosphine–borane compounds acting on several targets known to be relevant in cellular processes associated with apoptosis and neurodegeneration, thus suggesting their role as neuroprotective agents [13]. Additionally, Cuevas-Galindo et al. reported findings supporting the action of a new BCC exerting a positive influence on

Citation: Soriano-Ursúa, M.A. Boron Applications in Prevention, Diagnosis and Therapy for High Global Burden Diseases. *Inorganics* **2023**, *11*, 358. https://doi.org/10.3390/inorganics11090358

Received: 15 August 2023
Revised: 18 August 2023
Accepted: 29 August 2023
Published: 30 August 2023

glutamatergic neurotransmission, probably exerting modulation of glutamate release and excitotoxicity [14].

Also, a review by Estevez-Fregoso et al. regarding the effects of BCC modulating the actions of liposoluble hormones is included in this Special Issue. It compiles phenomena linked to the actions of steroid, thyroid, and calciferol-related hormones; among these are the effects on muscle mass and basal metabolism [15]. In fact, natural and synthetic BCCs have multiple potential actions to modulate disrupted metabolism in humans [16,17].

Finally, it must be stated attractive findings have been achieved which may allow us to alleviate common signs and symptoms linked to high global burden and limitation. Examples include studies on the synthesis of new non-steroidal anti-inflammatory drugs (NSAIDs); Abeysinghe et al. reported multi-functional bora–ibuprofen derivatives [18], but there have also been reports of BCC analogues to acetaminophen which can modulate pain. Other research groups have reported BCCs as controlled-release platforms for NSAIDs [19,20].

Therefore, no doubt exists about the expanding studies and applications of BCCs in medicine. Fortunately, the impact of these compounds is increasing due to multiple studies on their synthesis and biological activity by scientists from governments and private organizations around the world, particularly to solve problems involving diseases which limit the quality of life, life expectancy, death, and disability of millions of people.

Funding: Author thanks Secretaría de Investigación y Posgrado del Instituto Politécnico Nacional for financial support to projects to study and development of boron-containing compounds as potential drugs (Project: M2143).

Conflicts of Interest: The author declares no conflict of interest.

References

1. Vos, T.; Lim, S.S.; Abbafati, C.; Abbas, K.M.; Abbasi, M.; Abbasifard, M.; Abbasi-Kangevari, M.; Abbastabar, H.; Abd-Allah, F.; Abdelalim, A. Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. *Lancet* **2020**, *396*, 1204–1222. [CrossRef] [PubMed]
2. Murray, C.J.L.; Abbafati, C.; Abbas, K.M.; Abbasi, M.; Abbasi-Kangevari, M.; Abd-Allah, F.; Abdollahi, M.; Abedi, P.; Abedi, A.; Abolhassani, H.; et al. Five insights from the Global Burden of Disease Study 2019. *Lancet* **2020**, *396*, 1135–1159. [CrossRef] [PubMed]
3. Biţă, A.; Scorei, I.R.; Rangavajla, N.; Bejenaru, L.E.; Rău, G.; Bejenaru, C.; Ciocîlteu, M.V.; Dincă, L.; Neamţu, J.; Bunaciu, A.; et al. Diester Chlorogenoborate Complex: A New Naturally Occurring Boron-Containing Compound. *Inorganics* **2023**, *11*, 112. [CrossRef]
4. Kawano, Y.; Edwards, M.; Huang, Y.; Bilate, A.M.; Araujo, L.P.; Tanoue, T.; Atarashi, K.; Ladinsky, M.S.; Reiner, S.L.; Wang, H.H. Microbiota imbalance induced by dietary sugar disrupts immune-mediated protection from metabolic syndrome. *Cell* **2022**, *185*, 3501–3519. [CrossRef]
5. Spielman, L.J.; Gibson, D.L.; Klegeris, A. Unhealthy gut, unhealthy brain: The role of the intestinal microbiota in neurodegenerative diseases. *Neurochem. Int.* **2018**, *120*, 149–163. [CrossRef]
6. Ali, F.; Hosmane, N.; Zhu, Y. Boron chemistry for medical applications. *Molecules* **2020**, *25*, 828. [CrossRef]
7. Guseva, G.B.; Antina, E.V.; Berezin, M.B.; Nikitina, L.E.; Gilfanov, I.R.; Pavelyev, R.S.; Lisovskaya, S.A.; Frolova, L.L.; Ostolopovskaya, O.V.; Rakhmatullin, I.Z.; et al. Novel BODIPY Conjugates with Myrtenol: Design, Spectral Characteristics, and Possibilities for Practical Application. *Inorganics* **2023**, *11*, 241. [CrossRef]
8. Wang, Z.; Xing, B. Small-molecule fluorescent probes: Big future for specific bacterial labeling and infection detection. *Chem. Commun.* **2022**, *58*, 155–170. [CrossRef] [PubMed]
9. Das, B.C.; Nandwana, N.K.; Das, S.; Nandwana, V.; Shareef, M.A.; Das, Y.; Saito, M.; Weiss, L.M.; Almaguel, F.; Hosmane, N.S.; et al. Boron Chemicals in Drug Discovery and Development: Synthesis and Medicinal Perspective. *Molecules* **2022**, *27*, 2615. [CrossRef] [PubMed]
10. Ortiz-Flores, M.; González-Pérez, M.; Portilla, A.; Soriano-Ursúa, M.A.; Pérez-Durán, J.; Montoya-Estrada, A.; Ceballos, G.; Nájera, N. Reverse Screening of Boronic Acid Derivatives: Analysis of Potential Antiproliferative Effects on a Triple-Negative Breast Cancer Model In Vitro. *Inorganics* **2023**, *11*, 165. [CrossRef]
11. Oguzkan, S.B.; Turkez, H.; Ugras, H.I.; Tatar, A.; Mardinoglu, A. Oxidative, Genotoxic and Cytotoxic Damage Potential of Novel Borenium and Borinium Compounds. *Inorganics* **2023**, *11*, 324. [CrossRef]
12. Cacciatore, I.; Turkez, H.; Di Rienzo, A.; Ciulla, M.; Mardinoğlu, A.; Di Stefano, A. Boron-based hybrids as novel scaffolds for the development of drugs with neuroprotective properties. *RSC Med. Chem.* **2021**, *12*, 1944–1949. [CrossRef]
13. Morocz, Y.; Greben, R.E.; Levin, L.A. Redox Targets for Phosphine–Boranes. *Inorganics* **2023**, *11*, 310. [CrossRef]

14. Cuevas-Galindo, M.E.; Rubio-Velázquez, B.A.; Jarillo-Luna, R.A.; Padilla-Martínez, I.I.; Soriano-Ursúa, M.A.; Trujillo-Ferrara, J.G. Synthesis, In Silico, In Vivo, and Ex Vivo Evaluation of a Boron-Containing Quinolinate Derivative with Presumptive Action on mGluRs. *Inorganics* **2023**, *11*, 94. [CrossRef]
15. Estevez-Fregoso, E.; Kilic, A.; Rodríguez-Vera, D.; Nicanor-Juárez, L.E.; Romero-Rizo, C.E.M.; Farfán-García, E.D.; Soriano-Ursúa, M.A. Effects of Boron-Containing Compounds on Liposoluble Hormone Functions. *Inorganics* **2023**, *11*, 84. [CrossRef]
16. Messner, K.; Vuong, B.; Tranmer, G.K. The Boron Advantage: The Evolution and Diversification of Boron's Applications in Medicinal Chemistry. *Pharmaceuticals* **2022**, *15*, 264. [CrossRef] [PubMed]
17. Kan, F.; Kucukkurt, I. The effects of boron on some biochemical parameters: A review. *J. Trace Elem. Med. Biol.* **2023**, *79*, 127249. [CrossRef] [PubMed]
18. Abeysinghe, R.T.; Ravenscroft, A.C.; Knowlden, S.W.; Akhmedov, N.G.; Dolinar, B.S.; Popp, B.V. Synthesis of Novel Multifunctional bora-Ibuprofen Derivatives. *Inorganics* **2023**, *11*, 70. [CrossRef]
19. Kouadio, K.E.; Kambiré, O.; Koffi, K.S.; Ouattara, L. Electrochemical oxidation of paracetamol on boron-doped diamond electrode: Analytical performance and paracetamol degradation. *J. Electrochem. Sci. Eng.* **2021**, *11*, 71–86.
20. Cao, Y.; Khan, A.; Ghorbani, F.; Mirzaei, H.; Singla, P.; Balakheyli, H.; Soltani, A.; Aghaei, M.; Azmoodeh, Z.; Aarabi, M. Predicting adsorption behavior and anti-inflammatory activity of naproxen interacting with pure boron nitride and boron phosphide fullerene-like cages. *J. Mol. Liq.* **2021**, *339*, 116678. [CrossRef]