

Bismuth and Its Wide Applications

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ABSTRACT: This review describes the coining of the name of bismuth, recognition as an element from chemists and its main oxidation states. Its stability when it forms compounds and the relevance to chemotherapy due to high effectiveness and none to low level toxic profile. In modern medicine, the use of bismuth(III) is seen in nuclear medicine, anticancer, antitumor and antimicrobial studies. The challenge of bismuth(V) not to be stable in aqueous solution has made it to be less considered than bismuth(III).

KEYWORDS: Bismuth, bismuth(III), bismuth(V), anticancer, antimicrobial studies.

1. INTRODUCTION

The Greeks and Romans were unaware of bismuth until medieval period, despite the frequent mistaken nature with other metals [1]. In the 15th century, the first discovery of bismuth was known [2]. In 1450, Basil Valentine changed the first name of bismuth from wismut to its latinized name, "bisemutum", Potts and Bergman recognized bismuth as an element in 1739 [2]. Bismuth has an atomic number of 83 and it exists naturally as an oxide in form of Bi_2O_3 , carbonate in form of $(\text{BiO})_2\text{CO}_3$ and sulfide in form of Bi_2S_3 with mining byproduct of copper, lead and zinc [2]. Bismuth also possesses two major oxidation states like arsenic and antimony, which are Bi(III) and Bi(V), with others such as II and IV [2]. According to Pearson's theory of hard-soft acid base (HSAB), Bi(III) is a borderline metal ion, but in recent times, Bi(III) was discovered to have high affinity for both nitrogen and oxygen in aqueous solution. Bi(III) forms stable complexes with ligands of aminopolycarboxylate (APC) and polyaminopolycarboxylate (PAPC) ligands [3, 4]. Bi(V) compounds are unstable in aqueous solution [2]. Bismuth is an important heavy metal applicable in chemotherapy due to its high potency and low toxicity [1, 5]. In recent times, these ligands were coordinated with bismuth and later applied in nuclear medicine [3]. In the 17th century, bismuth subnitrate was used to treat various bacterial infections such as syphilis [5]. In 1786, Louis Odier gave a first report on the medical application of bismuth to treat dyspepsia [1, 2]. In 1889, Felix Balzer found out for the first time that bismuth might be applicable as antisyphilitic agent [2]. Two compounds of bismuth, namely; bismuth subsalicylate for the treatment of dyspepsia and diarrhoea and colloidal bismuth subcitrate for the treatment of peptic ulcers had been used worldwide since the 1970s [2]. In this contemporary time, compounds of bismuth are mainly applied clinically for gastrointestinal disorders as anti-ulcer agents [1]. Examples are De-Nol and Pepto-Bismol used to treat and prevent gastric and duodenal ulcers [1]. Tritec and pylorid were the latter drugs, whose names suggested the main aim of bismuth drugs to prevent the bacterium causing gastric complaints, known as bacterium *Helicobacter pylori*. *Helicobacter pylori* is an organism discovered in 1983, with a listing of Group 1 carcinogen by World Health Association [5]. This bacterium is also implicated in gastric lymphoma and mucosa-associated lymphoid tissue (MALT) lymphoma, leading to a potential relationship between bismuth

and cancer [1, 5]. Presently, the main medical applications of bismuth compounds are in anticancer and antimicrobial studies. A rationale for the application of compounds of bismuth in chemotherapy is to decrease the drawbacks of anticancer drugs like cisplatin and its analogues [1]. Advent studies showed the efficacy of some organometallic bismuth compounds as anticancer agents [1, 6]. Such compounds include (Na₂ [BiO (mp) 3] H₂O); (mp= 6-mercaptopurine), aryl bismuth oxine complexes, bismuth thiolates and (Bi(tgn) 3(H₂O)).3.5H₂O); (tgn-thioguanine), where bismuth compounds derived from 6-mercaptopurine were among the first anti-tumour trials [1, 7]. No Bi(V) has been screened for anticancer studies [5]. Bismuth compounds had been applied as antimicrobial agents to a variety of micro organisms [1]. With unknown mechanism of action, bismuth is recognized to hinder the growth of *Helicobacter pylori* [2]. There are few reports based on the toxic effects of bismuth(III) compounds, due to their notable catalytic none to low toxic and inexpensive qualities which make them very applicable in green chemistry [1, 8-11].

2. CONCLUSION

Researches in the study of bismuth compounds most especially bismuth(III) are increasing due to the none to low toxic and affordable properties. They are widely applied in catalysis, pharmaceutical and medical fields.

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