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Study on the Biological Weapon and their Detection Techniques

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Abstract:

Nowadays, the risk of biological and chemical agents is growing day by day. In these biological agents, certain fungi, bacteria and viruses represent a high risk for public health. Biological agents have the characteristics such as the unpredictable nature and have symptoms similar to common infection due to which the biological agents are used as a weapon by the terrorist to harm the large population. There are different types of methods that has been developed to detect these biological agents. These methods are Electrochemical Impedance Spectroscopy (ESI), Immunoassay techniques, Polymerase Chain Reaction (PCR) and Fluorescence techniques. These techniques have some advantages and disadvantages in the field of biological warfare due to which all biological weapon cannot be detected. In these review paper, we discussed about the different types of technique for the detection of biological weapons and concerns for the future.

Keywords: *Biological Agents, Weapon, Detection Techniques.*

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Introduction

Nowdays, the awareness is increasing regarding biological attacks vulnerabilities to military areas as well as civilian targets. The objective of homeland defense and national security is to protect the humans and animals against the biological warfare. 'Biological Warfare' means many biological agents that are used as weapons in mass destruction. The characteristics of these biological agents are to infect a large population with minimal economic cost.

From many centuries, the biological agents is used to beat enemies. The use of biological warfare (BW) has a historical record; in world war-I, anthrax biological warfare agent was used by Germans and Japanese against the human beings and animals. Again, it was used on large scale by Japanese against war prisoners and Chinese. The misuse of Biological Warfare Agent (BWA) is a possible event in the increment of threat of terrorist attacks. For a simple and cheap production of biological weapons, the misuse of biotechnology and food industry facilities are the one major problem (Joshi *et al.*, 2013; Trzaskowski and Ciach, 2017).

Biological Agents

A live pathogenic microorganism that are used to cause mass infection or poisoning of people, animals or plants is known as biological agents. The mechanism is as they penetrate in the human body and cause disease. Naturally occurring bacteria, viruses, fungi, rickettsiae and biological toxin are come under the biological agents (BAs).

The several groups of natural sources are divided according to the occurrence i.e. natural occurrence (spores of plants, pathogens coming from bacteria and fungi), agriculture and livestock production, hospital environment and infectious diseases, industrial and other processes. Two natural sources 'Natural and Agriculture' bio aerosols are usually merged with each other as during the handling of hey (straw), inhalation of aerosol or dust, may contain contamination from infected rodents. During the production and storage of grain, problems related to mycotoxins may also be encountered sometimes. Droplet infection is a transmission disease which is not limited to the hospitals, it spreads through the flu and viral infections are found around. There are several reason to use the biological agents as weapons which are:

1. Biological agents (BAs) are multiplied in the human body and give significant effect.
2. Biological agents (BAs) are highly toxic and virulent: these biological agents give their effect after some time, not immediately and transferred from one person to another person easily.
3. Biological agent is a 'Poor man's bomb' because it is inexpensive to construct as it can be grown in facilities such as pharmaceutical, food and medical production sites. There is time gap between infection and appearance of symptoms in the absence of adequate detection systems that gives the perpetrators a chance to escape.
4. The dose for infection in biological agents is very low as compare to other types of agents (like chemical agents). Samples of biological agent should be in milligram (mg) to gain the desired result (Joshi *et al.*, 2013; Svabenska, 2012).

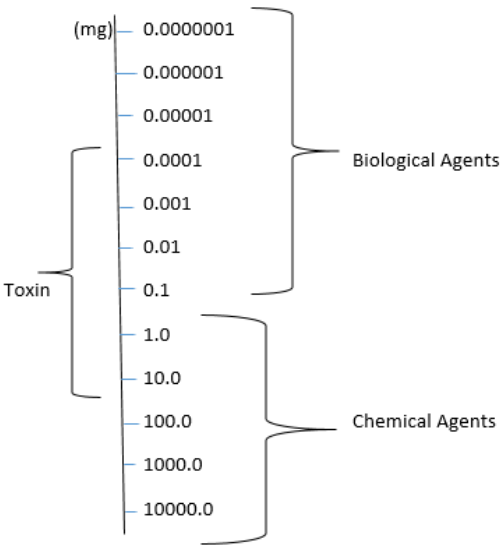

Figure 1: Agents dose (mg)

Classification of Biological Agents

Bio agents have been divided into five categories:

Bacterial Agents: - It is small, single-celled organism that grows on solid or liquid culture media. Different types of diseases are produced by bacterial

agents are Anthrax, Tularemia, Cholera, Diphtheria, plague and typhoid fever.

Viral Agents – It is simplest type of microorganism. It contains genetic material (either DNA or RNA) with coated protein. Different types of disease caused by viral agents are smallpox, yellow fever, dengue fever and Ebole.

Rickettsiae – It is obligate intracellular bacteria which have the size between bacteria and viruses with the common characteristics to both bacteria and viruses. Different types of diseases caused by rickettsiae are Q-fever, Endemic typhus and Rocky Mountain spotted fever.

Fungi – It may be unicellular or multicellular microorganism. It does not contain chlorophyll. It is generally used to destroy crops rather than human. Coccidioidomycosis disease caused in human by fungi.

Biological Toxin – It is a poison, not any organism that give adverse effect on humans. Biological origin toxin are Botulinum, Toxin, Saxitoxin and Ricin (Joshi *et al.*, 2013).

The effective protection against Biological warfare agents is difficult because of the detection of their presence is complicated and expensive. The biological agent infection is similar to the common infection due to which medical treatments are unsuccessful. After several studies, many devices are used for the detection and identification of biological agents. The point detection devices are the most available systems that can be used in field as well as at laboratory level but most of the device are commonly found in laboratories that are used for identification purpose. The detection and identification equipments of biological agents can also be stored on the basis of different fundamental principles (Svabenska, 2012).

Review of Literature

Svabenska (2012) gave a conclusion on the basis of his review, many factory made system for the detection of bio aerosols are generally used at hazardous places such as airports, subways, stadium, state buildings and semi enclosed facilities. He discussed in his paper about integrated detection system, spectroscopy and optical. There is need of trained operator for handling the devices except one hand held systems. Sample preparation is also an important steps in the detection and identification.

Joshi *et al.* (2013) discussed in their paper about biological agent 'Bacillus Anthracis' and their detection by Ultra violet Laser Induced Fluorescence (UV-LIF) spectroscopy method in which Intensified Charge Coupled Device (ICCD) spectrometer and Multi Anode Photo Multiplier Tube (MAPMT) were used for the detectors. They concluded in the end of paper that MAPMT based system gives better result **as** compared to ICCD in the term of sensitivity and UV-LIF-LIDAR system is best for the standoff detection of biological aerosols.

Ducote *et al.* (2016) proposed a method Electrochemical Impedance Spectroscopy (EIS) for the detection of pathogen 'ricin' (biological agent) and concluded that ESI is a highly sensitive, real time and non-destructive method for the detection of cytotoxin. Future perspective also discussed by Ducote et al as this technique can have the effective result on other toxins different from ricin in both case structure and mechanism of action.

Tomar *et al.* (2016) studied on the botulinum neurotoxin (BoNT/A) using surface plasmon Resonance (SPR) with carboxymethyldextran modified sensor chip. Electrochemical Impedance Spectroscopy (EIS) data were used for the confirmation of an effective interaction between the antigen and antibody. Different values were noticed such as limit of detection (LOD), kinetic parameter and Bmax values of immobilized antibody and immobilized synaptic vesicles. The main aim of this study was to give the inputs in the development of SPR based sensors by the help of antigen and antibody interaction for BoNT/A, and other BWAs.

Rowland *et al.* (2016) give an outlook of paper and concluded that nanomaterial based sensors techniques are more effective than the traditional techniques because of the high sensitive power and accuracy.

Trzaskowski and Ciach (2017) used Surface Plasmon Resonance (SPR) technique for the detection of biological agents. They concluded that the sensitivity of this method depends upon the type of biological agent. The detection limit is also different for each sensing chip that starts from 50 cfu/ml for V. cholerae bacteria. This technique, Surface Plasmon Resonance can be useful for the detection of biological agents.

Saito *et al.* (2018) in their paper 'Field-deployable rapid multiple bio sensing system for detection of

chemical and biological warfare agents' discussed about the collection and detection method for the biological agents. They developed an autonomous air sampling and detection system. The collection of biological and chemical agents was possible using designed collection system. Detection system 'ESI' is able to detect the concentration lower than the mean lethal dose, toxic proteins by Localized Surface Plasmon Resonance and Chip PCR is used to detect the Pathogens. Within 5-15 minutes, collection and detection of the biological and chemical agents is completed. In this research, they developed a compact and battery operated device that have all unit into on system.

Duracova *et al.* (2018) discussed in their review about the protein toxin and its detection methods. There are different types of methods have been developed such as immunochemical assays, MS based method, chromatographic method etc. But there is need to improve the state of detection in different ways such as upgrading the pre-analytical phase, suitable reagent and so on. They concluded that protein toxin cannot be detected by only one technique, a combination of techniques should be used to obtain the most information for complex samples.

Conclusion

The biological agents are the microorganism that are used as a weapon in war or by terrorists for harming the common people in large amount. Different methods have been developed which played a vital role in the detection of biological and chemical weapons which ultimately help the first responder and medical examiner in detecting the agent and then, cure the person. In spite of using these techniques and running programs (Biological Weapon Convention) against the biological warfare, the attacks of biological weapon are not under control. So, this review study concludes that there is need to develop more advanced techniques or implementation in the existing techniques to detect these weapons.

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