Metabolomics: Open Access
ISSN: 2153-0769

Buchko, Metabolomics 2013, 3:1
DOI: 10.4172/2153-0769.1000e125

Editorial Open Access

Microbial Metabolomics: towards Pathogen Detection and Biological Prospecting

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Microorganisms are complex biological systems that can have the ability to harm living organisms but can also produce beneficial metabolites. Rapid detection of microbial pathogens and comprehensive bio-prospecting of beneficial microorganisms are key aspects in microbial research.

Detection of microbial pathogens has been a mayor bottleneck in the human, animal, and plant disease diagnostics and control arenas. Detection of pathogens by traditional plating technologies can take from few days (some human and animal pathogens) to several weeks (some plant pathogens) and may require additional biochemical confirmation. Rapid technologies based on antibody or polymerase chain reaction (PCR) detection usually yield results in less than 48 h but can suffer from matrix interference and may show unacceptable limits of detection [1]. To overcome interference and limit-of-detection issues, an enrichment step prior to detection can be applied at the expense of the analysis duration time. However, with the increasing importance of bio-security and the emergence of pathogens worldwide, the need of reliable and rapid detection methods grows in importance.

In biological systems, the presence of microorganisms can cause changes in the metabolism of the host and metabolomic techniques can be used to diagnose diseases with high selectivity [2]. Similarly, pathogens can change the metabolite profile of the growth media in a precise manner and the metabolite profile of the media can be used to estimate the presence of an specific pathogen [1]. Metabolomics coupled to sensor development has the potential to provide rapid and reliable methods for pathogen detection. The metabolic fingerprint of a pathogen growing in a culture media can be the analytical target of an array of sensors. Results obtained from the sensor array and analyzed using multivariate methods can determine the presence of the pathogen in the sample.

The use of microorganisms for production of enzymes and metabolites has been the basis of many traditional biotechnological processes for centuries. With the discovery of new microbial species from previously unexplored habitats, bio-prospecting becomes a top priority. Traditional methods for finding beneficial metabolites from microorganisms rely on targeted tests requiring an a priori knowledge and the formulation of narrow hypothesis. Therefore, many metabolites of potential interest may be overlooked.

Metabolomics as a tool for bio-prospecting living organisms has provided a comprehensive assessment of the beneficial metabolites produced in plants [3]. Additionally, knowledge on functional genomics and the availability of databases including metabolites such as the Human Metabolome Database (HMD) [4] and metabolic pathways, such as those found on the Kyoto Encyclopedia of Genes and Genomics (KEGG) [5] can be used to better understand the metabolite production in living organisms. Metabolomics along with metabolite and metabolic pathways databases can provide an alternative for comprehensive bio-prospecting of microorganisms. Microorganisms can be exposed to specialized, enriched culture media and metabolomic techniques can be used to determine the released metabolites as a first bio-prospecting step. Metabolic pathways can then be proposed and further analyzed to assess the potential to produce additional metabolites.

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Received November 26, 2012; **Accepted** November 26, 2012; **Published** December 03, 2012

Citation: Cevallos-Cevallos JM (2013) Microbial Metabolomics: towards Pathogen Detection and Biological Prospecting. Metabolomics 3:e125. doi:10.4172/2153-0769.1000e125