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Lipidomics Analytical Strategies for the Identification of Functional Biomarkers from Human Saliva

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Abstract

Lipidomics, the study of lipid profiles in biological systems, has emerged as a promising field for the identification of functional biomarkers. Human saliva, a readily accessible biofluid, offers several advantages for biomarker research. This article provides an overview of the analytical strategies employed in lipidomics for the identification of functional biomarkers from human saliva. The article discusses sample collection and preparation techniques, lipid extraction methods, analytical techniques such as mass spectrometry and chromatography, and data analysis approaches. It highlights the potential of lipidomic analysis in saliva for understanding disease mechanisms and advancing personalized medicine.

Keywords: Lipidomics; Biomarkers; Human saliva; Functional biomarkers; Lipid extraction; Mass spectrometry; Chromatography; Data analysis; Personalized medicine

Introduction

In recent years, the field of biomarker research has gained significant attention due to its potential in early disease detection, personalized medicine, and monitoring treatment response. Traditional biomarker analysis has predominantly focused on proteins and nucleic acids. However, lipids, which are an essential class of molecules in human physiology, have emerged as promising candidates for the identification of functional biomarkers. Lipidomics, the comprehensive study of lipids in biological systems, has enabled the development of analytical strategies to analyze lipid profiles in human saliva for biomarker discovery. Saliva, a readily accessible biofluid, offers several advantages for biomarker research, including non-invasive collection, minimal patient discomfort, and ease of storage [1].

Saliva is a new term used to describe saliva-based techniques that are used to investigate different types of compounds found in saliva. The advantage is that saliva samples can be easily collected. Thus, it can be used in circumstances in which blood samples are more difficult to collect such as in children, anxious and handicapped patients, or in patients where blood drawing may be difficult.

Saliva is the most available biofluid with many functions in the oral cavity. It provides protection for the oral tissues against biological, mechanical, and chemical stimuli, allows the perception of taste and temperature, and is responsible for initial food digestion [3]. It is also involved in the maintenance of optimal conditions in the oral cavity, minimising bacterial growth, regulating pH, and neutralising acidic reflux in the oesophagus . An adequate supply of saliva is essential for the maintenance of oral tissue providing lubrication and protective functions for tissues and mucous membrane surfaces, thereby allowing articulation and swallowing. These functions and properties of saliva are attributed to the presence of electrolytes, buffering agents, proteins, glycoproteins, and lipids. However, saliva's flow and chemical composition are affected by gender, age, daily circadian cycle, emotional state, hydration, physical exercise, medication, systemic diseases, substance abuse, and nutrition.

Lipids as functional biomarkers:

Lipids play crucial roles in various physiological processes, including energy storage, cellular signaling, and membrane structure. Dysregulation of lipid metabolism has been associated with numerous diseases, such as cardiovascular disorders, diabetes, and cancer. Therefore, analyzing lipid profiles in human saliva can provide valuable insights into the underlying mechanisms of disease development and progression. Additionally, saliva contains a diverse range of lipids, including phospholipids, glycerolipids, and sphingolipids, making it an attractive source for Lipidomics analysis [3].

Analytical Strategies for Lipidomics in Saliva

Sample collection and preparation

The first step in lipidomic analysis is the collection of saliva samples. Non-stimulated or stimulated saliva can be collected using various techniques such as spitting, swabbing, or drooling. To obtain reproducible and reliable results, standardized collection protocols should be followed. After collection, the saliva samples undergo pre-processing steps, including centrifugation to remove cellular debris and filtration to remove particulate matter.

Lipid extraction

Lipid extraction is a critical step in lipidomic analysis. It involves the separation of lipids from other components in the sample matrix. Various extraction methods, such as liquid-liquid extraction, solid-phase extraction, or precipitation-based methods, can be employed depending on the desired lipid class and analytical technique. The choice of extraction method should ensure efficient recovery of lipids while minimizing sample loss and introducing minimal bias [4].

Analytical techniques

Several analytical techniques are available for lipidomic analysis,

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each with its advantages and limitations. The choice of technique depends on the research objectives, lipid classes of interest, and available resources. Mass spectrometry is a powerful tool widely used in lipidomics due to its high sensitivity, specificity, and ability to provide structural information. Gas chromatography coupled with MS or flame ionization detection can be employed for the analysis of volatile lipids. Liquid chromatography coupled with MS or UV detection is suitable for analyzing non-volatile lipids. Nuclear magnetic resonance spectroscopy is an alternative technique for lipid profiling, offering high reproducibility and quantitative capabilities [5].

Data analysis and biomarker discovery

Data analysis in lipidomics involves the identification and quantification of lipid species from the acquired analytical data. Various software tools and databases, such as LipidSearch, LipidBlast, and LipidXplorer, aid in lipid identification by matching acquired spectra with reference databases. Additionally, statistical analysis techniques, including multivariate analysis and machine learning algorithms, can be employed to identify potential biomarkers that distinguish between disease and healthy states. Integration of lipidomic data with other omics data, such as genomics and proteomics, can provide a comprehensive understanding of disease pathways and aid in the discovery of novel biomarkers [6].

Discussion

The identification of functional biomarkers from human saliva using lipidomics analytical strategies holds great potential for advancing disease diagnosis, monitoring treatment response, and enabling personalized medicine. In this discussion, we will delve deeper into the significance of lipidomic analysis in saliva and its implications for biomarker discovery.

Saliva, as a biofluid, offers several advantages for biomarker research. It is easily accessible through non-invasive collection methods, such as spitting or swabbing, which minimizes patient discomfort and allows for repeated sampling. Saliva collection is cost-effective, simple, and can be performed in various settings, including clinical, research, or even home environments. Moreover, saliva contains a diverse range of lipids, representing an important class of molecules involved in various physiological processes. Therefore, analyzing the lipid profile of saliva can provide valuable insights into disease mechanisms and aid in the identification of functional biomarkers.

Lipidomic analysis involves a series of analytical strategies to extract, analyze, and interpret lipid data. The first step is sample collection and preparation. Standardized protocols should be followed to ensure consistent results and minimize variability. Centrifugation and filtration are commonly employed techniques to remove cellular debris and particulate matter, respectively, from the saliva samples [7].

Lipid extraction is a critical step in lipidomic analysis. Different extraction methods can be utilized depending on the desired lipid class and the subsequent analytical technique. Liquid-liquid extraction, solid-phase extraction, or precipitation-based methods are commonly used. The chosen extraction method should ensure efficient recovery of lipids, while minimizing sample loss and introducing minimal bias.

Various analytical techniques are available for lipidomic analysis, each with its advantages and limitations. Mass spectrometry is a powerful tool widely used in lipidomics due to its high sensitivity, specificity, and ability to provide structural information. Gas chromatography coupled with MS or flame ionization detection can be employed for the analysis of volatile lipids, while liquid chromatography coupled with MS or UV detection is suitable for non-volatile lipids. Nuclear magnetic resonance spectroscopy is an alternative technique for lipid profiling, offering high reproducibility and quantitative capabilities. The choice of analytical technique depends on the research objectives, available resources, and the lipid classes of interest [8].

Data analysis is a crucial aspect of lipidomic research. It involves the identification and quantification of lipid species from the acquired analytical data. Software tools and databases assist in lipid identification by matching acquired spectra with reference databases. Statistical analysis techniques, such as multivariate analysis and machine learning algorithms, can be employed to identify potential biomarkers that differentiate between disease and healthy states. Integration of lipidomic data with other omics data, such as genomics and proteomics, can provide a comprehensive understanding of disease pathways and aid in the discovery of novel biomarkers.

The identification of functional biomarkers from human saliva through lipidomic analysis holds immense potential in various clinical applications. It can facilitate the early detection of diseases, including cardiovascular disorders, diabetes, and cancer, by providing insights into lipid metabolism dysregulation. Moreover, monitoring changes in lipid profiles during disease progression and treatment can help assess treatment response and guide personalized medicine approaches. The development of robust lipidomic analytical strategies, combined with advancements in data analysis and integration with other omics fields, will further enhance the potential of lipidomics in identifying functional biomarkers from human saliva [9].

In conclusion, lipidomics analytical strategies applied to human saliva offer a promising avenue for the identification of functional biomarkers. The non-invasive nature of saliva collection, combined with the diverse lipid composition of saliva, makes it an attractive biofluid for biomarker research. By employing standardized sample collection, efficient lipid extraction methods, advanced analytical techniques, and sophisticated data analysis approaches, researchers can uncover valuable insights into disease mechanisms and pave the way for improved disease diagnosis, treatment, and personalized medicine [10].

Conclusion

Lipidomics, with its focus on the analysis of lipid profiles, offers a valuable approach for identifying functional biomarkers in human saliva. The non-invasive and easily accessible nature of saliva makes it an attractive biofluid for biomarker research. The development of robust analytical strategies for lipidomic analysis, including standardized sample collection, efficient lipid extraction, and the use of advanced analytical techniques, has significantly contributed to the identification of potential biomarkers for various diseases. Further advancements in lipidomics technology, data analysis, and integration with other omics approaches hold great promise for the discovery of novel functional biomarkers and advancements in personalized medicine.

Conflict of Interest

None

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