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New Methodologies for Nutritional Diagnostics

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ABSTRACTS

Developments in Personalized Nutritional Diagnostic for Improving Health

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Precision and personalized nutrition has steadily emerged to address the large heterogeneity in individuals' responses to diet, by tailoring nutrition based on the specific requirements of each person (e.g., general wellbeing and specific individuals' goals). The potential of personalized and precision nutrition and its impact on society is massive, it aims at preventing and managing wellbeing and specific conditions, by formulating personalized dietary interventions (including behaviors) to individuals on the basis of their metabolic profile, background, and environmental exposure.

Diagnostic has become one of the most important building blocks of the personalized nutrition ecosystem. Over the past few years numerous strategies for measuring individuals' needs were developed and made commercially available (mainly on-line distributed laboratory tests). Moreover, from a research perspective, numerous academic groups are heavily working on diagnostic and Point of Care (PoC) solutions which will soon enable a more precise and reliable collection of nutritional-related information.

While wearable and mobile devices have shown a massive growth over the past decade, their potential for tracking and guiding nutrition has only raised over the past few years. Currently, the most common approach for maintaining optimal nutritional status, is by mainly following guidelines imparted by doctors and dietitians. However, such recommendations rely on population averages and do not take into consideration individual's essential parameters, such as the variability in responding to nutrients and lifestyles.

New diagnostic PoC concepts aiming for collecting information supporting personalized nutrition programs are constantly launched or proposed by startups, frequently picking academic research ideas and intellectual properties. These new emerging PoC diagnostic devices are frequently using sensing concepts based on electrochemistry, immunoassays, NDIR, MOSFET, Optical readout, microfluidic/colorimetric, fluorescence.

However, precision nutrition is not relying only on diagnostic and PoC devices. The interpretation of the data collected, and the formulation of nutritional supplements delivery systems are equally important, and the success of personalized nutrition programs will depend by a well-balanced and synchronized integration of the here mentioned 3 main factors (Diagnostic, Data/Digital, and Delivery Systems). By providing timely dietary information, such wearable and mobile sensors will offer the guidance necessary for supporting dietary behaviour change toward a managed nutritional balance.

Developments in Dietary Fibre Estimation Techniques in Food

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Dietary fibre forms an important part of the human diet and is a common food additive due to its impact on digestion and health. Dietary fibre is a diverse group of carbohydrates found almost exclusively in plants, including non-starch polysaccharides such as cellulose, pectin and lignin. Unlike other types of carbohydrate, these are not absorbed in the small intestine to provide energy. Some fibre can be fermented in the **large intestine** by gut **bacteria**, producing short chain fatty acids and gases (methane, hydrogen and carbon dioxide). Dietary fibre provides 2 kcal/8 kJ per gram on average.

The Codex Alimentarius Commission spent almost two decades developing a definition of dietary fiber that would be recognised globally. The Dietary Fibre definition adopted in June 2009 means carbohydrate polymers (with ten or more monomeric units), which are not hydrolysed by the endogenous enzymes in the small intestine of humans and belong to the following categories: 1) Edible carbohydrate polymers naturally occurring in the food as consumed, 2) Carbohydrate polymers, which have been obtained from food raw material by physical, enzymatic or chemical means and which have been shown to have a physiological effect of benefit to health as demonstrated by generally accepted scientific evidence to competent authorities and synthetic carbohydrate polymers which have been shown to have a physiological effect of benefit to health as demonstrated by generally accepted scientific evidence to competent authorities. This definition includes resistant starch (RS), a component not accurately measured by the dietary fibre methods then available.

Depending on the total dietary fibre content and its specific constituents, different nutrition and health claims are allowed. Depending on the DF content, products can be claimed with 'source of fibre' or 'high fibre'. Also, various health claims related to blood cholesterol, bowel function and faecal bulking are globally accepted by EFSA. Therefore, it is important to measure the dietary fibre content using fit-for-purpose' methods. A variety of different methods have been applied for total dietary fibre determination in food that have been validated and accepted. In the laboratory it is measured using the standard enzymatic-gravimetric method with or without a chromatographic step. Basically, the food sample is treated with enzymes to mimic the digestive process in the human small intestine. Digestible carbohydrates are broken down into simple sugars and removed from the sample after precipitation and filtration. The non-digestible precipitate contains the dietary fiber but also contains protein and inorganic material, which are estimated. Modifications to the standard methods allow dietary fiber content to be further evaluated as soluble and insoluble dietary fibre. Choosing an appropriate method is based on the labelling requirements and the type of claims that are to be used on the label. These methods will be discussed.

Food 3D Printing for Personalized Nutrition

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Among the various approaches to food customization, the concept of 3D printing has gained huge interest in recent years. As an additive manufacturing approach, a novel range of foods can be printed with zero wastage. Given its capabilities, 3D printing is regarded as a disruptive technology with prospects for changing the way how food is manufactured. In this talk, the focus is on one key application, its scope for supporting personalized nutrition. With 3D printing, customized foods for various age groups and special needs can be conveniently prepared. For instance, high-protein snacks, texture-modified foods for those with swallowing difficulties, foods for astronauts and soldiers on long duration missions, physical-structure modified low GI foods, etc., can be prepared with both variety and aesthetic appeal. Based on demand, nutrients and functional ingredients such as probiotics and food bioactives can be supplemented to cater to individual requirements. These can be monitored in real-time using IoT and data analytics approaches integrated with the analyses of nutritional biomarkers.

Additionally, hybrid approaches involving encapsulation, electrospraying/electrospinning, etc. have found promising potential for the development of healthy and low-salt foods. As a 'print and eat' technology, food 3D printing primarily revolves around three concepts – printability, post-printing & post-processing characteristics, and applicability. Food materials exhibit intricate physical and chemical behaviors and their composition significantly affects printability. While some foods are natively printable, others may require suitable pre-processing to make them printable. This being stated, extrusion-based food 3D printing is the most popular approach and this talk will cover different applications, primarily, our recent studies. With changing consumer preferences, 4D printing is an evolving application with requirements for further research and optimization. While the focus of 3D printing can be different in other sectors, in food technology, it must go along with the development of nutritious foods for a healthy population. This also implies a better understanding of the food destructuring process in the human body and scientific interventions to improve nutrient bioavailability and develop customized and/or personalized foods.