Smart Technologies for personAlised Nutrition and Consumer Engagement

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The world is currently facing a nutritional transition, characterised by unhealthy dietary patterns leading to an increase in non-communicable diseases such as type 2 diabetes, obesity and the metabolic syndrome (WHO, no date). Great efforts are being paid to promote healthier diets and lifestyles around the world. Stance4Health proposes a complete smart personalised nutrition (SPN) service based on the use of mobile technologies as well as tailored food production that will optimise the gut microbiota activity and promote long-term consumer engagement. The Stance4Health project (Smart Technologies for personAlised Nutrition and Consumer Engagement) is funded by the European Union's Horizon 2020 research and innovation programme (www.stance4health.com). It involves a consortium of 19 partners from eight European countries (Spain, Germany, Denmark, Romania, Italy, Greece, Belgium, UK). To reach this ambitious objective, the project includes six different research and innovation work packages.

Modulation of gut microbiota through diet

Nowadays, the **gut microbiota is known to affect host health** at different levels: competing with pathogens, interacting with the immune system or producing either beneficial or detrimental metabolites (Marungruang *et al.*, 2016). Hence, it is thought to play a critical role in the modulation of host physiological processes related to chronic diseases (obesity, type 2 diabetes, etc.). The microbiota feeds on dietary components which remain undigested in the upper gut and ferment them to different health-affecting substances such as short-chain fatty acids (SCFAs) which are positive or indoles which are negative (Tremaroli and Bäckhed, 2012). Since preventing chronic diseases is currently a major concern, and one of the **UN Sustainable Development Goals**, modulating and **optimising the gut microbiome via diet** has been drawing much interest. There is where Stance4health comes in, building a mathematical algorithm able to predict gut microbial behaviour in response to a specific diet and vice versa (Figure 1). This would allow the recommendation of a personalised diet based on each individual's gut microbiota needs.

Food databases to be implemented in the mobile app

The complexity of the global food system is increasing and decision making for citizens and food-sector actors in a plural world of

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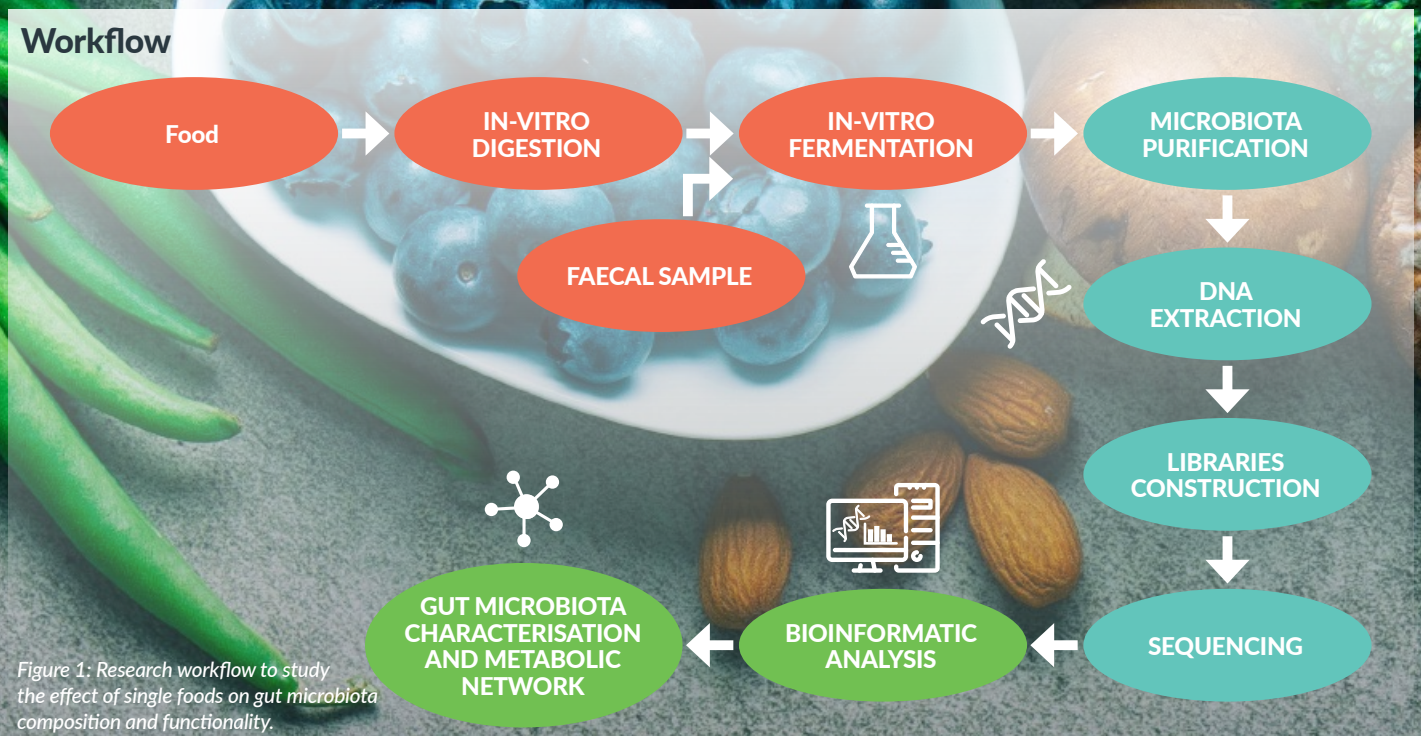

Figure 1: Research workflow to study the effect of single foods on gut microbiota composition and functionality.

information, products and services is highly demanding. European citizens must be given education and tools to make choices that result in healthy diets that are also sustainable (Fabbri, 2017). In this sense, Stance4Health aims to create a complex food database, as complete as possible, with raw foods, processed foods and foods that are currently found on the market. This will be made possible by bringing together nutritional information from different food databases from different countries (Spain, Germany and Greece—complemented by others), to increase the number of nutrients (Phenolexplorer, Italy, USDA, etc.). Additionally, an image database of raw/cooked foods and barcodes of foods sold by retailers will be set up. The effect of intersectionality, age, gender, race and social class on the size of food portions will be studied, as they play an important role in defining the amount of food consumed. Portion sizes with a higher selection rate will be included in the food database image. A large number of recipes for typical and traditional dishes from the countries involved in the project are being collected. This will ensure that the menus proposed to consumers are as close as possible to their usual diet, but taking into account the nutritional composition according to the needs of each person.

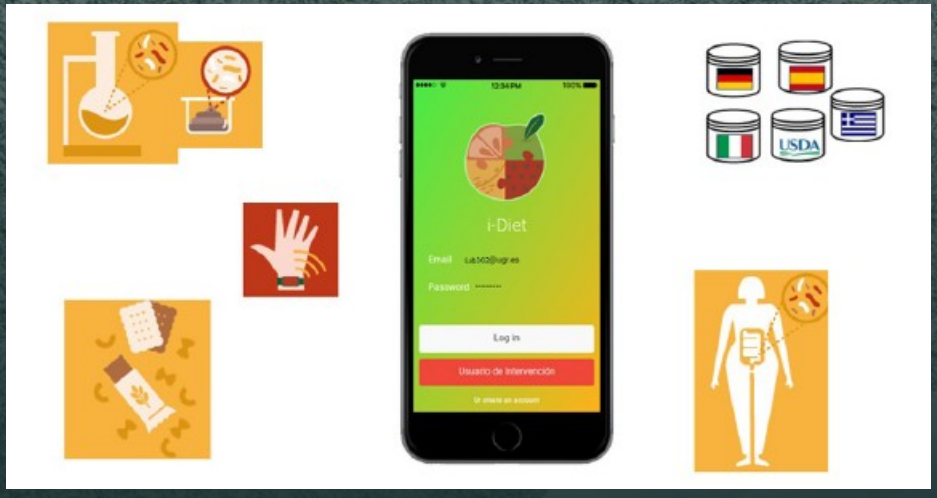

Figure 2: Components of the Stance4Health app.

Dietetic software (mobile application) for consumers

SPN services and products rely on accurate and appropriate data about things such as food choices, preferences and analysis of menus (Daniel *et al.*, 2016). There are currently some applications that are capable of generating diets or assessing the user's diet. Stance4health proposes a different and innovative approach. The objective is to offer a unique SNP service, able not only to generate healthy diets but also to account for the nutritional requirements, the modification of the gut microbiota, to be connected to wearables and to recommend fortified foods or dietetic supplements according to each individual's needs.

The Stance4health application will provide the necessary tools for the user to self-manage their diet and generate new habits (Figure 2). The application will be able to generate proposals for healthy diets taking into account the likes and possible pathologies such as allergies or intolerances. Also, the application will challenge the user to accomplish the objective through a system of messages and notifications. The user will learn how to have a healthier diet, introduce new health-promoting foods and also how to have a more adequate intestinal microbiota, getting more information about the food environment around you (Figure 3).

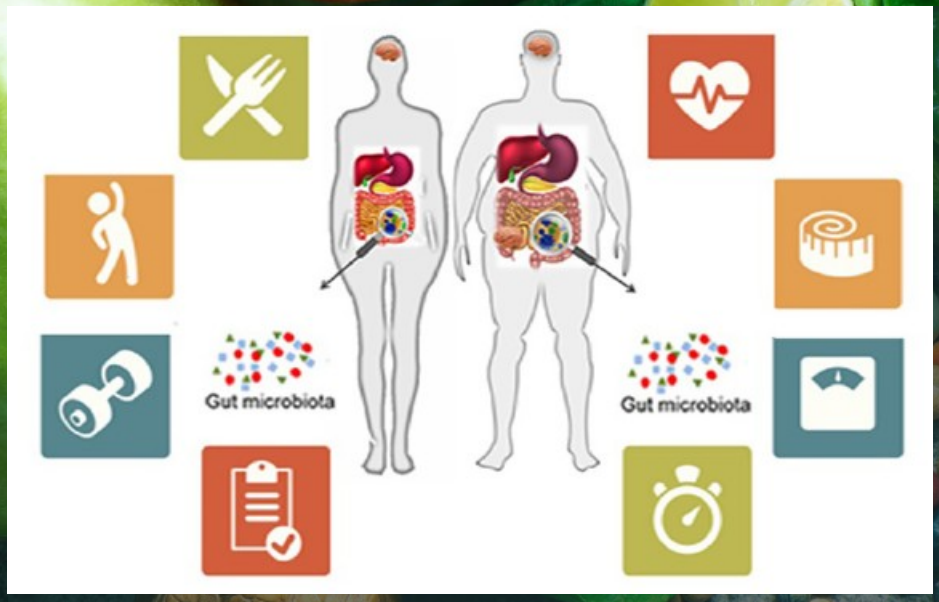

Figure 3: Main functionalities of the Stance4Health app related to gut microbiota modulation.

Stance4Health will develop the core mobile app with similar functionalities to that of the nutrition professional's software, such as the generation of personalised diets based on health status, objectives, nutritional habits and nutritional pyramid pattern. The final result will be a menu with complete nutritional information, instructions on how to prepare the recipes and an accompanying shopping list—all to facilitate the user reaching an optimum diet. The mobile application will be developed in the languages used for the human trial (German, Greek and Spanish) and English. Consumers will be allowed to choose among food portions and commercial foods at markets by linking barcodes with their nutritional composition. Stance4Health will also develop a module that will enable users to connect with wearable technology to monitor physical activity, heart rate or sleeping hours, and also to perform anthropometric analysis by bioimpedance.

Consumer studies on software acceptance and food-market preferences

We will assess how personalised nutrition can empower consumers. The use of large cohorts will ensure the maximum diversity within Europe in terms of subjective value-being and health-related history. We will use different approaches to assess the understanding of the drivers of food choice—such as the food environment, ethical factors (i.e. use of personal data, GPS positioning, etc.) and gender. These drivers influence the motivation and behavioural change needed to adopt and continuously use SPN to maintain long-term healthy and sustainable diets. We will also assess how these factors interact with the design characteristics of mobile devices enabling SPN. In addition, a final study will evaluate the economic impact on changes in consumer spending on food and the impact of the technology on food producers and retailers.

Design of customised foods for specific and vulnerable target groups

Another important pillar of SPN is the development of functional foods for targeted population groups. The introduction of novel prebiotics targeting specific microbial activities will have a deep impact both on the gut microbial balance as well as human health (celiac disease, food allergies, obesity). Stance4Health's approach to developing functional foods is based on the design of two new cereal-based food products. The products will include different doses of tannins and riboflavin. Tannins are secondary metabolites of plants, and fruits are the main sources in the diet. Tannins also have the ability to precipitate proteins. In this sense, Dias *et al.* (2016) found that tannins have binding selectivity towards immunoreactive peptides, so decreasing allergenicity for celiac disease patients. Finally, another new type of prebiotic, riboflavin (vitamin B2), has been proposed for the treatment of pathologies such as inflammatory bowel disease (Sadaghian, 2015). Also, some nutraceutical products will be used if the nutritional requirements of the consumer will allow. The customised production of foods and nutraceuticals for specific population groups like healthy and overweight adults, or children with coeliac disease or food allergy will strengthen.

Validation of the SPN strategies in adult and children populations, in a near to operational environment

One of the central objectives of the Stance4Health project will be the development of an intervention programme based on the ongoing study of in vitro digestion-fermentation of regular foods and designed to validate a novel SPN service. The nutritional intervention will last 12 weeks. It will be carried out on adults between 20 and 65 years of age in Germany and Spain and children in Greece (normal weight, obese, with coeliac disease or allergy to different foods). The intervention will have three phases (Figure 4):

1. Pre-intervention phase—where those subjects who meet the requirements would be recruited, their consent would be requested, and the first surveys and analysis of the microbiota would be carried out).
2. Intervention phase—through personalised nutrition strategies and where participants will be randomly assigned to two different levels of intervention:

   i. Level 1 (low level of intervention), which will include the use of the mobile application and the analysis of the composition of the intestinal microbiota.

   ii. Level 2 (high level of intervention), which will comprise level 1 activities plus the use of personalised fortified foods and the nutraceutical. An intelligent bracelet will be used to monitor activity, and a diagnostic tool will be used to assess the metabolites in the urine.
3. Post-intervention phase—accompanied by analysis of the impact of the technology on the subjects.

In conclusion, all these objectives have been designed based on a deep understanding of the role of SPN. Overall and specific objectives of Stance4Health clearly align with the foreseen impact of the project and the expected exploitation/commercialisation of the developed technologies.

Figure 4: Structure of human nutritional interventions along Stance4Health.

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PROJECT SUMMARY

The overall objective of Stance4Health is to develop a complete smart, personalised nutrition service based on the use of mobile technologies, as well as tailored food production that will optimise the gut microbiota activity and long-term consumer engagement. The project will focus on both adult population (lean and overweight people) and children (lean, obese, coeliac disease or food allergy).

PROJECT LEAD PROFILE

Stance4Health is led by **Prof. José Ángel Rufián-Henares,** Professor of Nutrition & Food Sciences at the University of Granada (Spain). Prof. Rufián-Henares has a strong background in food processing, food composition analysis and the effect of food on gut microbiota composition and functionality.

PROJECT PARTNERS

The Stance4Health consortium consists of 19 partners from eight European countries (Spain, Germany, Denmark, Romania, Italy, Greece, Belgium, UK). Six SMEs will be in charge of the development and future commercialisation of a new app for personalised nutrition, tailored cereal-derived foods, one nutraceutical and one in vitro diagnostic test to control the gut microbiota activity.

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