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Introduction

1.1 MOTIVATION

Food is a central factor in our lives and forms the basis of nutrition. Cultures across the world have evolved diverse culinary practices and a rich repertoire of recipes that characterize them. Thus, cooking comes across as one of the central tenets that has shaped cultures and civilizations. Gastronomy encompasses the study of various culinary dimensions encompassing food, culture, cooking, aroma, taste and health, and has been pursued with an artistic outlook hitherto. The investigations presented in this thesis are motivated by the search for the basis of flavor in traditional recipes and the health impact of food ingredients. For these studies, we have chosen to focus on the rich culinary practices from the Indian subcontinent, which have been influenced by the health-centric dietary practices.

Importantly, this thesis brings forth the relevance of data-driven investigations of culinary practices to probe the molecular basis for their taste and palatability as well as their health impacts. It presents some of the earliest studies in a niche, interdisciplinary discipline of Computational Gastronomy, an emerging data science of food, flavor and health. In a globalized world where the food trends are changing rapidly and are influencing the spread of non-communicable diseases such as diabetes and obesity, investigations that probe for the basis of flavor and health would have an immense impact driving the public health policy. The rise of computational gastronomy is rooted in the availability of data on diverse components such as traditional recipes, flavor compounds in ingredients and linked data of their health associations among others. The availability of data and advances in the computational analysis (natural language processing, machine learning and such) are enabling the transition of gastronomy into a data-driven science.

Data-driven investigations such as those presented in this thesis are expected to lead to developments that would transform the global culinary landscape by integrative studies that probe the molecular basis of taste and health in recipes. Within the context of culture, these advances can help in creating novel recipe generation, algorithms and culinary recommendation systems aimed at palatable and healthy recipes.

1.2 OBJECTIVES

This thesis focusses on the investigation of flavor pairing patterns in the Indian cuisine and health impacts of culinary herbs and spices. Following are the objectives of the thesis:-

- To study the nature of food pairing in recipes of Indian Cuisine.
- To explore the molecular (flavor) mechanism behind the combination of ingredients in traditional recipes of Indian cuisine.
- To create a repertoire of flavor compounds in natural ingredients.
- To investigate the health impacts of culinary spices and herbs by mining biomedical literature.
- To integrate the data on the therapeutic effects of spices with an aim of providing disease-specific culinary recommendations.

1.3 CONTRIBUTIONS

By investigating the food pairing pattern in the traditional Indian recipes we show that, in contrast to the positive food pairing trend followed by certain cuisines, Indian recipes follow a contrasting (negative) food pairing— more the extent of flavor sharing between two ingredients, lesser is their co-occurrence in recipes [Jain, Rakhi, and Bagler, 2015a, 2015b]. Our studies provide a basis for designing novel signature recipes, healthy recipe alterations and recipe recommender systems. We also developed a comprehensive repository of naturally occurring flavor compounds, FlavorDB [Garg et al., 2017]: a resource for exploring the space of flavor molecules (http://cosylab.iiitd.edu.in/flavordb).

We implemented a text mining protocol to assess the health impact of spices by assimilating, both their positive and negative effects [Rakhi, Tuwani, Mukherjee, and Bagler, 2018]. We conclude that spices show broad-spectrum benevolence across a range of disease categories in contrast to adverse effects that are comparatively narrow-spectrum. We also implement a strategy for disease-specific culinary recommendations of spices based on their therapeutic tradeoff against adverse effects. Further, by integrating spice-phytochemical-disease associations, we identify bioactive spice phytochemicals potentially involved in their therapeutic effects. Our study provides a systems perspective on the health effects of culinary spices and herbs with applications for dietary recommendations as well as identification of phytochemicals potentially involved in underlying molecular mechanisms.

Further, we created SpiceRx (http://cosylab.iiitd.edu.in/spicerx), a systematic compilation of evidence-based knowledge pertaining to the health impacts of culinary spices and herbs [Rakhi, Tuwani, Garg, and Bagler, 2018]. It provides a platform for exploring the health impact of spices and herbs used in food preparations through a structured database of tripartite relationships with their phytochemicals and disease associations.

1.4 THESIS OVERVIEW

The main body of this thesis is organized into seven chapters. In Chapter 2, we provide a comprehensive survey of the literature related to the main concepts discussed in the thesis. Chapter 3 illustrates the outline of the study undertaken for studying the food pairing in Indian cuisine and the nature of the compilation of the data on recipes and flavors. Chapter 4 discusses the main results of the food pairing in Indian Cuisine and the basis for the food pairing. Detailed food pairing analyses for various Indian regional cuisines are described in Chapter 5. In Chapter 6, we describe FlavorDB, a database of flavor compounds. In Chapter 7, we lay down a text mining protocol for associating the health effects of spices and herbs. Chapter 8 presents the results of the data-driven analysis of biomedical literature on culinary herbs and spices. Chapter 9 describes SpiceRx, a database designed to integrate the published data on the health effects of spice and herbs.

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