



Symposium on Data Mining Applications, SDMA2016, 30 March 2016, Riyadh, Saudi Arabia

Exploring the Food Pairing Hypothesis in Arab Cuisine: A Study in Computational Gastronomy

Shahad Talal Tallab^a, Muna Saleh Alrazgan^b *

^{ab} King Saud University, College of Computer and Information Sciences, Riyadh 12371, Saudi Arabia

Abstract

The love to explore propelled the humans to try and discover new things. One of which is experimenting with food to come up with new flavours. Eating a strawberry with chocolate will create a unique taste, while eating the strawberry with cheese will create a completely different taste. The concept behind these combinations is something called food pairing. The science behind food pairing is widely studied in the Western and European gastronomic societies. In contrast, there are no reported studies of that nature conducted in the Arab counterparts. Our research will be the first to examine the food pairing hypothesis in Arab cuisine. This hypothesis states that food with common flavour compounds taste good when consumed together. For the purpose of validating the hypothesis, a quantitative mathematical model will be developed and applied on a dataset consisting of ingredients compounds found in Arab cuisine recipes. In this paper, we are presenting a proof-of-concept of our ongoing project, as well as showing the steps that will be followed to apply the food pairing on Arab cuisine

© 2016 Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).
Peer-review under responsibility of the Organizing Committee of SDMA2016

Keywords: Food pairing; Arab cuisine; flavor network; flavor compounds; computational gastronomy; data mining.

1. Introduction

The French gastronome Jean Anthelme Brillat-Savarin once said in 1826 “Tell me what you eat, and I’ll tell you who you are”¹. Cuisine is a vital part of any culture. It reveals many characteristics about the people who belong to it, and facts related to where they live, what types of crops their land grow, and what their climate is like. World’s cuisine differs from each other in the ingredients that are use and the preparation style that is adopted in cooking.

* Corresponding author. Tel.: +966-506-735-308.

E-mail address: 435204013@KSU.edu.sa

Throughout history, food preparation was done through trial and error. Scientists also assumed this experimental method when they studied the chemical makeup of food to understand more about the ingredients and their interactions. With the help of computer technology, the field of food science was able to mature to the point of rapidly growing into a quantitative research field². One of the most prominent quantitative researches in food science was the study in food pairing hypothesis that got more and more attention since its discovery in 1992 by Heston Blumenthal, the renowned chef of the famous Fat Duck restaurant³. This hypothesis claims that food that shares a lot of common flavor compounds taste delicious together. Researchers from different cultural background investigated this hypothesis in relation to their cuisine. Some cuisine like the Western cuisine showed positive pairing, meaning the ingredients used in the recipes of that cuisine tended to share more compounds of flavor. While, East Asian and Indian cuisines proved quite the opposite result, ingredients with more shared compound were less likely to occur in the same recipe⁴. At this point, the paper will present the outlined process-cycle of our ongoing project that aims to investigate the food pairing in Arab cuisine.

2. Background & Literature review

Gastronomy as a term is the art or science of good eating⁵. The latest outburst of data on food ingredients, their chemical makeup and pairing combinations, in addition to the application of data mining, and knowledge extraction techniques, caused the emergence of a new field called “Computational Gastronomy,” a term coined by Ahnert in 2013⁶. Additionally, the world’s cuisines comprise of the European cuisine, the North American cuisine, the Latin American cuisine, the Asian cuisine, and the Arab cuisine. The Arab cuisine encompasses a wide variety of local cuisines covering the Arab world from Mesopotamia to North-Africa⁷. Up to our knowledge there is no science behind what gives each cuisine its signature savory taste and aromatic smell. So, who is responsible for the different tastes and flavors that give each of the world’s cuisine its defining features? One answer would be the volatile chemical compounds found in food. These chemicals simulate the nerves receptors in the nose and the mouth to create the food experience.

The field of food science received more attention in western research. In 1992 Chef Heston Blumenthal, the founder of The Fat Duck restaurant and the author of a cookbook with the same name, found that caviar and white chocolate taste good together. Further studies led to the birth of “The Food Pairing Hypothesis,” which states that certain ingredients mix well together if they share similar chemical compounds³.

Judging whether the food pairing hypothesis is true drew the interests of many researchers to investigate its validity across the diversity of world’s cuisine. A recent study⁴ built bipartite flavor network that shows the chemical components shared by culinary ingredient. The study showed that while Western and European cuisine are inclined toward using ingredients that share similar flavor compounds, East Asian cuisine tended to do the exact opposite. It also emphasized that the ethnic and the cultural aspect of a cuisine play a role in deciding the ingredients of a recipe rather than the actual chemistry of the ingredients. A research conducted on flavor pairing in medieval European cuisine and the result reveal that the food pairing was found to be positive in European recipes⁸.

The latest study conducted on testing the hypothesis was published this year focusing on the Indian cuisine^{9,10}. The authors worked to quantify the food pairing pattern and constructed models in order to find features that clarify the statistical properties of the cuisine. The bottom line was that the higher the number of shared compounds between any two ingredients of an Indian recipe, the lower their co-occurrence probability.

3. Methodology

There are four major phases for our project. We illustrate each section as follows:

4.1 Data collection and curation

In this phase, we will collect the recipes from major cooking websites like Hawa World. Recipes with their respective ingredients are counted. Furthermore, ingredients are matched to their source ingredients in order to remove aliases and to map them to their corresponding food categories.

4.2 Flavor sharing calculation

During this phase the mean number of shared flavour compounds among ingredients ($N_s(R)$) in a recipe (R) that contain different ingredients (C_i, C_j) with flavour compound set are computed two pairs of ingredients at a time as shown in the equation below as discussed in^{4,8}.

$$N_s(R) = \frac{2}{n_R(n_R-1)} \sum_{i,j \in R, i \neq j} |C_i \cap C_j|$$

4.3 Ingredients contribution

The next phase revolves about calculating the degree of involvement of each ingredient to the shared compound effect by this equation. As illustrated in^{4,8} and shown in the following equation.

$$X_i = \frac{1}{N_c} \sum N_s(R) - \left(\frac{2f_i}{N_c n_R} \frac{\sum_{j \in C} f_j |C_i \cap C_j|}{\sum_{j \in C} f_j} \right)$$

4.4 The uniqueness of the ingredients category:

The final phase will assess the distinctiveness of each ingredient by comparing it with a reference recipes assembled randomly from the recipes dataset using the following equation discussed in^{4,8}.

$$\Delta N_s = \overline{N_s}^{real} - \overline{N_s}^{rand}$$

The result of the previous equation will be one of the following results that will provide the answer of the hypothesis:

- The result is positive: ingredients tend to share many flavour compounds in the recipes under consideration thus validating the food-pairing hypothesis.
- The result is zero: there are no relationship between food pairing and recipe.
- The result is negative: ingredients in the recipes tend to share few flavour compounds.

4. Conclusion

Over the last years, food science gained a lot of attention in the Western and European countries especially about the new field of computational gastronomy. Moreover, the application of knowledge extraction on data in food science was impressed to empower the food businesses in new unexplored directions. The food pairing hypothesis was all the rage during 1990s. Not only chefs got interested in this hypothesis, but also scientist from various disciplines started to explore it with relation to different national cultures and cuisines. Fortunately, once this new field is recognized in countries of the Arab world, it will open doors for future opportunities to restaurants and home cooking businesses to become confidently innovative. Suffice to say that a project like this will scratch the surface to what lay beneath computational gastronomy.

References

1. C. G. St-Pierre, "Faunal Remains as Markers of Ethnicity: A Case Study," Conference of the International Council for Archaeozoology (ICAZ), p. 11, Aug. 2006.
2. "What are importance of computer to food-science and technology," Answers.com. [Online]. Available: http://www.answers.com/Q/What_are_importance_of_computer_to_food-science_and_technology. [Accessed: 26-May-2015].
3. H. Blumenthal and H. Blumenthal, *The Fat Duck cookbook*. London: Bloomsbury, 2009.
4. Y. Ahn, S. Ahnert, J. Bagrow and A. Barabási, 'Flavor network and the principles of food pairing', *Scientific Reports*, vol. 1, 2011.
5. Merriam-webster.com, 'gastronomy | the art or activity of cooking and eating fine food', 2015. [Online]. Available: <http://www.merriam-webster.com/dictionary/gastronomy>. [Accessed: 27- Apr- 2015].
6. S. E. Ahnert, "Network analysis and data mining in food science: the emergence of computational gastronomy," *Flavour*, vol. 2, no. 1, p. 4, 2013.
7. "Arab cuisine," Wikipedia, the free encyclopedia. 21-May-2015.
8. K. R. Varshney, L. R. Varshney, J. Wang. & D. Myers, 'Flavor Pairing in Medieval European Cuisine: A Study in Cooking with Dirty Data,' *CoRR*, 2013.
9. Jain, R. N. K, and G. Bagler, "Spices form the basis of food pairing in Indian cuisine," 2015.
10. A. Jain, G. Bagler, and R. N. K, "Analysis of food pairing in regional cuisines of India," arXiv: 1502.03815 [physics, q-bio], p. 15, 2015.