Latin Food 2024
11th Food Science, Biotechnology & Safety Congress
Asociación Mexicana de Ciencias de los Alimentos A.C.
MEXICAN ASSOCIATION OF FOOD SCIENCE

Generation of food substitutes using artificial intelligence: a combined approach of supervised modeling and genetic algorithms

Daniel Hernández Mota[1*], Cesar Lozano Díaz[2], and Raquel Zúñiga Rojas[3*]

Instituto Tecnológico y de Estudios Superiores de Occidente (ITESO), Jalisco, Tlaquepaque, México.

Presenting and *corresponding authors: daniel.hernandezm@iteso.mx, rzuniga@iteso.mx

Abstract

This research explores the use of Artificial Intelligence (IA) techniques, specifically Machine Learning (ML) and Genetic Algorithms, to drive practical innovation in food engineering. The innovative approach integrates diverse data sources on relevant food characteristics, such as flavor molecules and profiles with their respective functional groups, as well as nutritional values [1-3]. A Random Forest [4] binary classification model was developed that compares food products in pairs, learning to identify similarities with promising performance (Area Under the Curve of the Precision-Recall relation (AUC PR) of 0.898). This model was integrated into an iterative genetic algorithm that proposed optimized lists of ingredients to replicate target products such as cheese, milk, and butter. The generated candidates achieved similarity scores between 0.5 and 0.7, indicating an 80% probability of preserving nutritional and sensory properties comparable to the original products, but with a completely different ingredient composition. This methodology demonstrates the potential of AI to innovate in food product design and personalization, contributing to diversification, sustainability, and accessibility in the food industry.

Keywords: Artificial Intelligence, Machine Learning, Genetic Algorithms, food engineering.

[1] Garg, N., Sethupathy, A., Tuwani, R., Rakhi, NK, Dokania, S., Iyer, A., Gupta, A., Agrawal, S., Singh, N., *et al*. (2017) FlavorDB: A database of flavor molecules, Nucleic Acids Research, Nucleic Acids Research, Volume 46, Issue D1, 4 January 2018, Pages D1210–D1216, https://doi.org/10.1093/nar/gkx957, [2] U.S. Department of Agriculture, Agricultural Research Service, Beltsville Human Nutrition Research Center. FoodData Central. [Internet] [cited (18/04/2024)]. Available from https://fdc.nal.usda.gov/, [3] EDAMAM (2024). Food database API. [Internet] [cited (18/04/2024)]. Available from: https://developer.edamam.com/food-database-api, [4] Breiman, L. "Random forests." Machine learning 45.1 (2001): 5-32.