

AN INGREDIENT IDENTIFICATION ALGORITHM FOR PLANT-BASED, SUSTAINABLE AND HEALTHY PROTEIN FORMULATION

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INTRODUCTION

The demand for protein ingredients has increased dramatically over the last few years. This ever-rising interest stems from the growing global population and the associated social-economical changes such as urbanisation, increased income, the concept of healthy diet and changes in dietary patterns with an increased focus on sustainability. As a result, food processors can no longer depend on common and traditional recipes to fulfil evolving customer requirements. Most food processors are currently seeking alternatives to the less sustainable animal-based protein ingredients in existing cuisines and formulations by switching to plant-derived, algae-derived and insect-derived proteins, etc. However, the research and product development has turned out to be costly and time-consuming, involving a great deal of lab work. The potential of incorporating artificial intelligence (AI) as an aid to overcome such formulation barriers and to expedite product development has been well identified by the food science research community.

METHODOLOGY

This study aims to introduce a novel algorithm to identify the potential for substituting more sustainable raw materials for existing protein ingredients in a food formulation. Raw beef was used as the anchor ingredient for developing the algorithm. The nutritional composition of raw beef was established using alternative and more sustainable ingredients. In this study, 16 plant-based ingredients that can serve as viable protein sources were analysed. Nutrient profile data of the selected ingredients were extracted from the public food composition databases FAO/INFOODS and USDA-FoodData Central and arranged into a comma-separated value (CSV) file. The analytical hierarchical process (AHP) decision-making approach and the k-nearest neighbours algorithm were used to process the data. Several portions of each ingredient combination were evaluated, considering the essential amino acid profile. AHP was used to identify the next most viable ingredient for supplying the least-fulfilled amino acid in the formulation. The identified formulation quantities of proteins were used to calculate the overall nutrient composition of the food formulation.

RESULTS

The k-nearest neighbours algorithm was used to identify the most closely matching ingredient mix for beef comprising alternative and more sustainable (plant-based) ingredients. By this approach, 153 different combinations (formulas) were identified, and four dominant ingredients were also identified from the results based on the fulfilment of the essential amino acid profile.

DISCUSSION

The preliminary results indicate the algorithm is a viable approach to identifying the initial ingredient combinations required for formulating novel and sustainable protein-based recipes as substitutes for existing animal protein-based recipes. Furthermore, it would be useful to identify the potential for using neglected and underutilised crops (NUCs) to produce value-added products in the sustainable protein industry for healthy diet formulations.