Hybrid Machine Learning and Statistical Modeling: an alternative and cost-effective approach for food product formulations to combat malnutrition

Dr Syazana Abdullah Lim, Dr Hasnizan Taib
and Dr Muhammad Norfauzi Bin POKDPDP Hj Dani

Universiti Teknologi Brunei

Introduction

Developing formulations for food products - method of ‘trial and error’.

Design a formulation with pre-selected ingredients and then readjust the ingredients in the formulation in order to meet certain specifications.

Repeated as many times as necessary to achieve a satisfactory product.

However- costly and time consuming

Aims and Objectives

The aims of this research are to:

1. develop food product-process models
2. streamline and accelerate the development and deployment of models
3. use these models for translational output from prototype to industrial scale production

Specifically, the objectives of this research are to:

1. screen the most important factors in optimizing formulation of food bar
2. design and optimize a novel formulation for a nutrient-dense food bar
3. employ and develop machine learning models to predict formulations for scaled-up production

Proposed Method

Phase 1: Food product optimization will be carried out using a multi-step experimental design. The first step involves screening to investigate the critical control factors from many potential factors using Plackett-Burman design

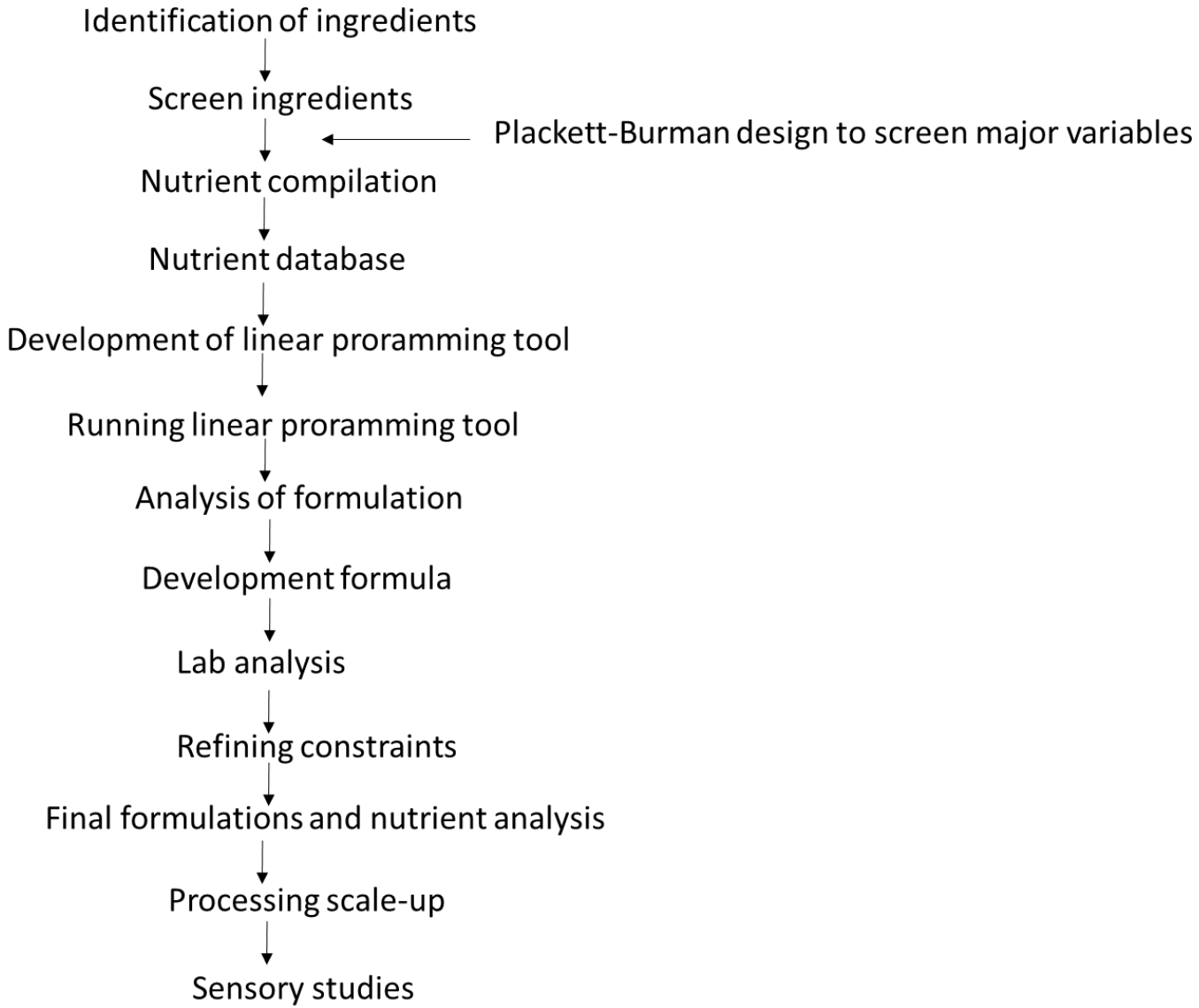
Phase 2: This stage involves optimizing the screened factors so that the product having the desirable quality is obtained using LP model. Determination of constraints

Phase 3: The main approach to be employed in transferring laboratory-based formulation to industrial scale is *via* Quality by Design (QbD).

Designed Experiment (DOE) to determine which variable exerted the greatest influence on dissolution and Strategy of Experimentation approach to be used in the development of formulations

Phase 4: Employ machine learning to predict optimised formulations based on a set of input variable constraints

Proposed Method



Impact of this project

With AI, food scientists can now use algorithms to analyze consumer preferences, ingredient combinations, and sensory data to create unique and appealing flavors.

Assists with food process optimization techniques by developing a model to predict the optimal solution for given input data.

Crucial part in optimizing the nutritional value of food products.

AI assists product development process by reducing time and cost.

Impact of this project

Powerful tool – for Micro, Small and Medium Industries (MSMEs)

Small companies often have limited resources, and linear programming can help minimize costs by optimizing resource allocation - more **efficient** use of materials, labor, and other resources, ultimately reducing operational expenses.

Small food companies can use linear programming to optimize recipes, helping them find the right balance of ingredients to achieve desired taste, texture, and nutritional profiles while minimizing costs - **improved product** quality and lower production expenses.

Assist small food companies in designing and formulating products with specific **nutritiona**l targets, such as reducing sodium content, increasing protein levels, or meeting dietary guidelines. – a trend in health-conscious consumers and regulatory compliance.

Output/Outcome of this project

This work will be in collaboration with local Micro, Small and Medium Industries (MSMEs) and planned to be part of a national-funded research to assist MSMEs community.

A workshop will be conducted to disseminate knowledge with ASEAN countries.

Conclusion

- Developing formulations for food products is the method of ‘trial and error’.
- To use AI in formulation of food products
- Plackett-Burman experiments , Linear Programming and Machine Learning
- Capacity building
- Assist food companies in their food formulation efforts
- More efficient recipe optimization and improved product quality