



Development of Omega-3 Enrich Halal Plant-based Snack : AI-Driven Nutritional Optimization of Halal Snacks from Local Thai Crops: A Framework for Advancing SMEs in Product Design and Commercialization

Suwaibah Sulong^{1,2}, Hasam Chebako^{1,2}, Firadao Boonmalert^{1,2}, Sarin Chaovasuteeranon^{1,2}, Kasinee Katelakha^{1,2*}, and Winai Dahlan^{1,2}

¹The Halal Science Center, Chulalongkorn University, Bangkok, Thailand, ²The Halal Innovation Community Learning Center, Nakhon Nayok, Thailand
*Corresponding author: Kasinee Katelakha/ E-mail:Kasinee.k@chula.ac.th

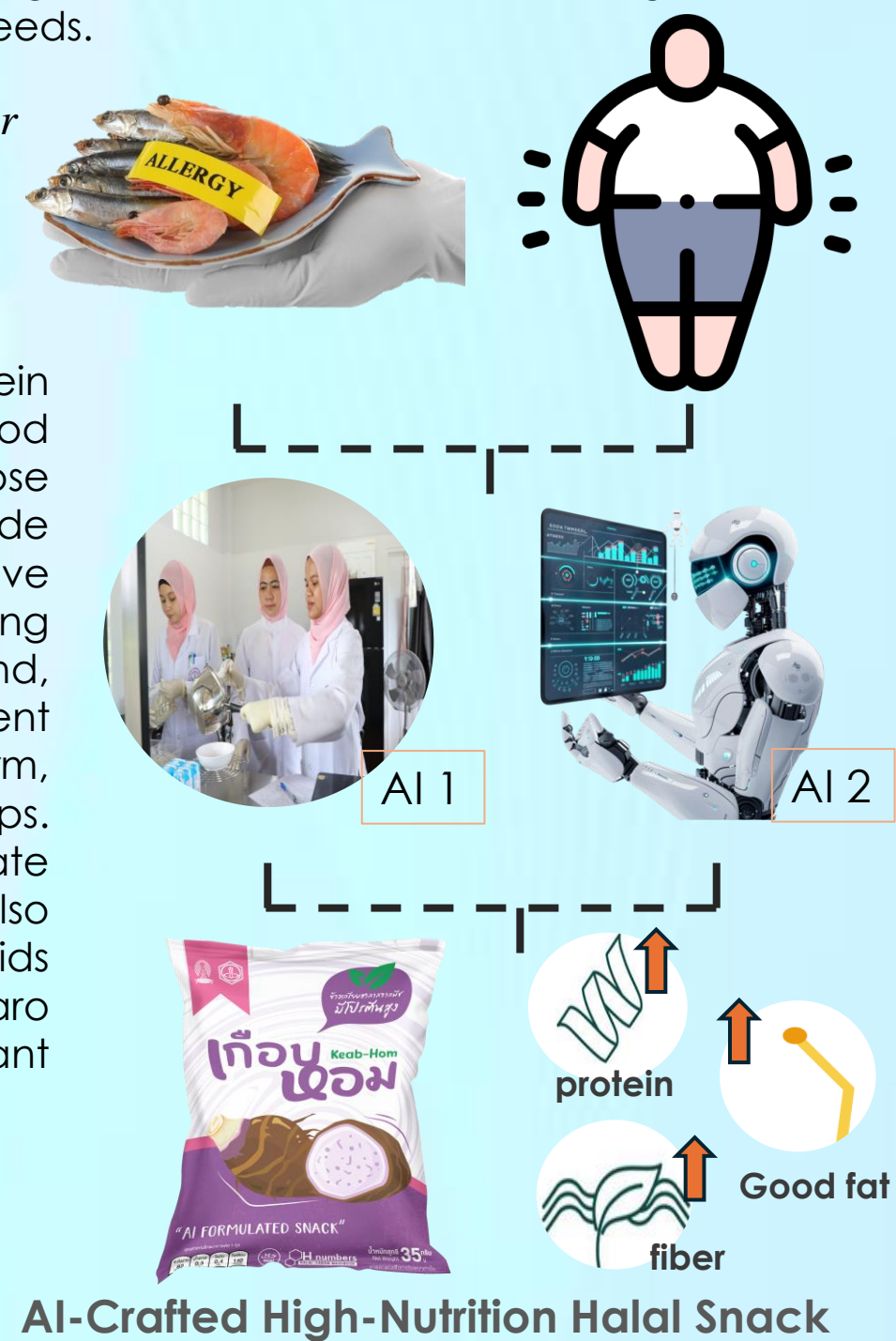
ABSTRACT

Although shrimp and fish chips are popular among consumers, some individuals are allergic to seafood-based products. The primary advantage of these chips over plant-based alternatives is their higher protein and omega-3 content. The aim of this study was to develop a plant-based chip with protein and omega-3 content comparable to that of seafood-based chips available on the market. The master formula was generated using the AI-driven ChatGPT platform, with prompts designed to optimize the ingredient composition. The resulting formula was prepared and tested. The nutritional profile of the product was calculated by ChatGPT and was then compared with results obtained from proximate analysis to validate its performance. The master formulation comprises of taro (50.0%), tapioca starch (30.0%), *Wolffia globosa* (5.0%), perilla seed oil (1.0%), garlic (1%) salt (0.8%) and natural color (1.0%) which provide a nutrient-rich, plant-based alternative healthier snack. Utilizing AI, the nutritional profile was optimized, resulting in a low-fat, high-fiber product with no added sugar and moderate sodium levels. The taro chip was prepared according to the formula provided by AI and the nutrition fact was calculated using AI compared to those that were analyzed with laboratory-based proximate analysis. The result found that each 35g serving delivers approximately 106 kcal. This formulation offers a low-calorie, plant-based snack with moderate carbohydrates, low fat, and added omega-3 benefits. The analysis highlights the competitive advantage of incorporating AI in nutritional optimization, enabling the creation of snacks that address both health and religious dietary needs.

Keywords: *Fragrant taro, Wolffia globosa, Perilla Seed Oil, Protein, Halal product, Crispy cracker*

INTRODUCTION

Shrimp and fish chips are popular snacks due to their appealing flavor and high nutritional value, particularly their protein and omega-3 fatty acid content. However, such seafood-based products are unsuitable for individuals with seafood allergies, and they may not align with the dietary restrictions of certain consumer groups, such as vegetarians or those adhering to Halal dietary laws (Rahman et al., 2019). This has led to a growing interest in plant-based alternatives that provide comparable nutritional benefits while catering to a broader market segment (Kumar et al., 2022). Plant-based snacks have gained significant attention as a healthier and more sustainable food choice, with consumers increasingly demanding products that align with health, environmental, and ethical values (Euromonitor International, 2023). In response to this trend, artificial intelligence (AI) has emerged as a powerful tool for food product development, enabling precise ingredient optimization to meet specific nutritional and functional goals (Zhao et al., 2021). This study utilized an AI-driven platform, ChatGPT, to develop a plant-based chip with protein and omega-3 content comparable to traditional seafood-based chips. The primary ingredient, taro (*Colocasia esculenta*), is a locally available crop in Thailand known for its high carbohydrate content and versatility in food applications (Sompong et al., 2018). To enhance the nutritional profile, the formulation also incorporated *Wolffia globosa*, a protein-rich microalga, and perilla seed oil, a plant-based source of omega-3 fatty acids (Matsuo et al., 2020). This paper presents the development process, nutritional profile optimization, and validation of the taro chip formulation. The findings demonstrate the potential for AI-assisted food innovation to create healthier, Halal-compliant snacks tailored to meet the needs of diverse consumer groups.



METHODS



Selecting low-value local plants with good fiber and carbohydrate content:
Taro (*Colocasia esculenta* (L.) Schott)



The product was designed and optimized by incorporating a good source of Omega-3 from perilla seed oil and significant protein content from *Wolffia*.



The developed product underwent sensory testing to evaluate its potential for commercialization, aiming to sustainably increase the value of local natural products.

RESULTS

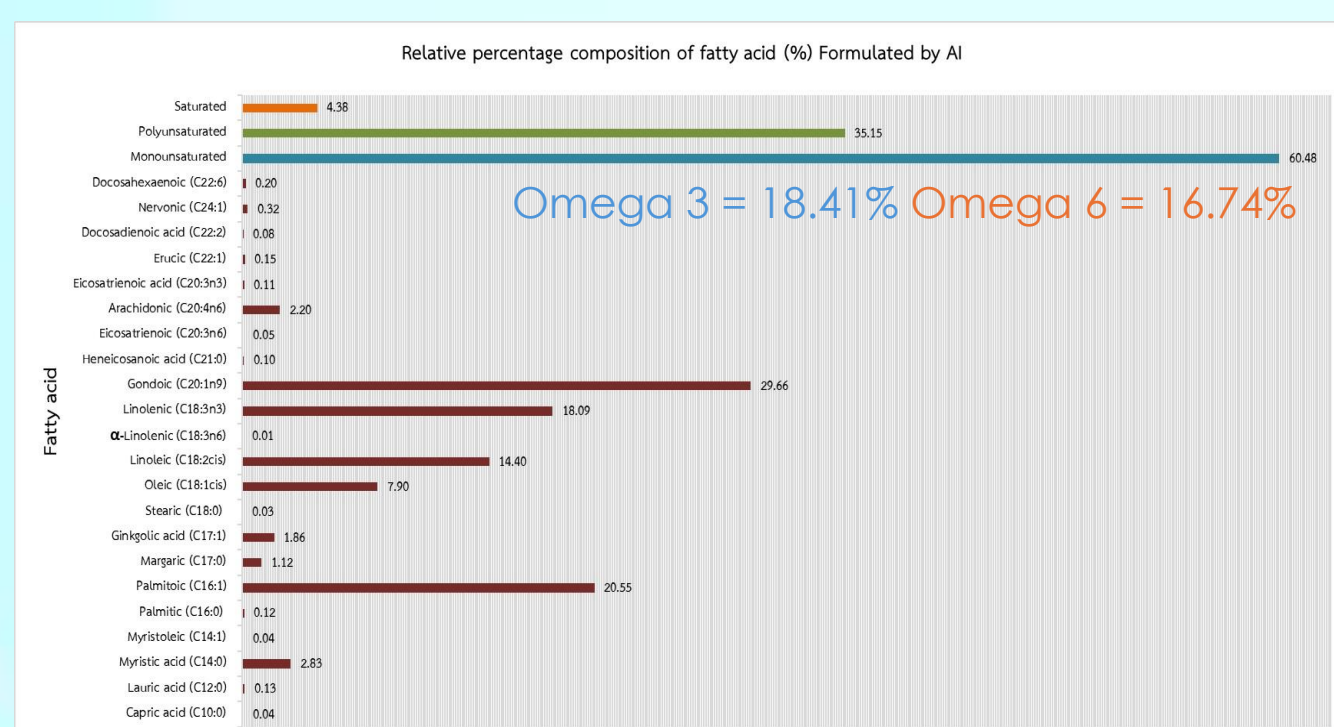


Figure 1 Relative percentage composition of fatty acid

The fatty acid profile of the AI-formulated taro chip showed a high monounsaturated fatty acid (MUFA) content of $60.48 \pm 5.03\%$ and polyunsaturated fatty acid (PUFA) content of $35.15 \pm 2.16\%$, with 18.41% Omega-3, primarily derived from perilla seed oil. The proximate analysis revealed that carbohydrates, fats, and proteins were present at 75.74 g/100 g, 2.21 g/100 g, and 5.82 g/100 g, respectively.

The results showed that the nutritional values obtained from laboratory analysis were comparable to the AI-predicted values, with minor differences observed. These discrepancies may be attributed to several factors, including inherent variability in raw materials, slight deviations in ingredient composition during formulation, and potential processing losses during preparation. Overall, this study demonstrates the potential of AI-driven formulation tools in developing nutritionally optimized snacks while underscoring the importance of laboratory validation to ensure accuracy and reliability in real-world applications.



CONCLUSION

The formula for a plant-based halal snack, developed using AI, was evaluated through proximate analysis and fatty acid profile testing. Results revealed that the nutritional values obtained from laboratory analysis were comparable to the AI-predicted values, with minor differences observed. These discrepancies can be attributed to several factors, including the inherent variability in raw materials, slight deviations in ingredient composition during formulation, and potential processing losses during preparation. Overall, this study demonstrates the potential of AI-driven formulation tools in developing nutritionally optimized snacks while highlighting the importance of laboratory validation to ensure accuracy in real-world applications.

REFERENCE

- Rahman, M. S., et al. (2019). Overview of seafood-based snack consumption and dietary challenges. *Journal of Food Studies*.
- Kumar, S., et al. (2022). Plant-based snacks: Market trends and health implications. *Sustainable Food Systems*.
- Euromonitor International. (2023). Trends in health-conscious food consumption.
- Zhao, X., et al. (2021). Artificial intelligence in food product development. *Trends in Food Science & Technology*.
- Sompong, R., et al. (2018). Nutritional and functional properties of taro: A versatile crop. *Food Science Journal of Thailand*.
- Matsuo, M., et al. (2020). Omega-3 fatty acids from perilla seed oil: Health benefits and applications. *Journal of Functional Foods*.

The developed product was also pitched to business partners to receive feedback and recommendations, and it was awarded the **First Runner-Up prize**