Thesis Title	The Influence of Drying Methods on the Quality Characteristics of Kai (*Cladophora glomerata*) Powder and Its Potential Application in Dysphagia Food Formulation
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ABSTRACT

People with dysphagia require foods that are safe to swallow, and 3D food printing offers a promising approach for developing such texture-modified products; however, its effectiveness depends on the availability of ingredients with suitable functional and rheological properties. Kai (*Cladophora glomerata*), a freshwater alga traditionally consumed in Northern Thailand, is rich in protein, minerals, and bioactive compounds. However, its functional properties are strongly influenced by drying methods. This study investigated the effects of freeze-drying (FD), sun drying (SuD), and tray drying at 50°C (TD) on Kai powder properties and its potential application in 3D-printable dysphagia-friendly food formulations.

In Phase I, fresh Kai was processed by FD, SuD, and TD, and the resulting powders were evaluated for proximate composition, mineral content, *in vitro* protein digestibility, chlorophyll and phytochemical content, antioxidant and anti-inflammatory activity, techno-functional properties, microstructure, and FTIR characteristics. TD retained the highest protein (13.95 %), chlorophyll (4.41 mg/g), flavonoid (6.60 mg QE/g), and antioxidant (FRAP: 20.86 mmol Fe^{2+}/g) contents, along with the greatest absolute digestible protein yield (9.57 g/ 100 g) and exhibited potent anti-inflammatory activity at low concentrations (12.5–25 µg/mL), suppressing NF-κB-mediated inflammatory responses while strongly activating the Nrf2/HO-1 antioxidant defense pathway. Sun drying showed the highest phenolic content, DPPH activity, water holding capacity, and protein digestibility (82.55 %). FD preserved superior emulsifying properties and demonstrated anti-inflammatory activity at 100–200 µg/mL.

All drying methods produced mineral-rich powders with heavy metal contents below EU safety limits.

Due to its superior balance of nutritional quality, functional performance, and practical scalability, TD was selected for Phase II and formulated with xanthan gum (XG) and konjac gum (KG) using response surface methodology. Sixteen formulations were evaluated for rheological behavior, texture profile, print accuracy, syneresis, deformation, microstructure, and dysphagia-oriented texture characteristics. All formulations exhibited pseudoplastic shear-thinning behavior. Formulations with total gum between 6 % and 9 % and XG:KG ratios of approximately 1:2 to 3:1 gave the best print accuracy and passed IDDSI Level 4, Japanese Standard Regulation, and UDF Stage 4 criteria. The RSM models showed good predictive performance (R^2 = 0.8456–0.9750) and the predicted optimum formulation contained 5.265 % xanthan gum and 3.186 % konjac gum.

Overall, the findings demonstrate that drying-induced structural modifications strongly influence the functional performance of Kai powder and highlight the potential of tray dried Kai as a functional ingredient for personalized dysphagia-friendly 3D food printing applications. Validation of the predicted optimum formulation remains to be performed to confirm its practical printing performance.

Keywords: Freshwater Algae, Drying Techniques, Bioactive Compounds, Techno-functional Properties, 3D Food Printing, Hydrocolloids