A Study on the Physical Properties of Banana Flour as a Functional Ingredient for Food Applications

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Abstract

Background - Bananas (Musa spp.) are fast-growing plants that can be cultivated year-round throughout all provinces of Thailand. Banana flour is derived from natural raw materials and is considered to have a low glycemic value. Consumption of bananas or banana flour has been associated with potential benefits in reducing the risk of diabetes, cancer, and cardiovascular diseases. In addition, it possesses a characteristic aroma and exhibits favorable physical properties. Investigating the physical properties of banana flour may highlight its potential as an alternative ingredient in various food applications. Moreover, such knowledge can contribute to value addition and enhanced its utilization.

Derign/methodology/approach - Unripe bananas from Nakhonnayok, Thailand, were dried at 60 °C for 48 h, ground, and sieved (80–100 mesh) to obtain unripe banana flour (UBF). The flour was extracted with 80% ethanol at a 1:10 (w/w) ratio at 70 °C, filtered through Whatman No. 1 filter paper, and the solvent was removed under reduced pressure. Total phenolic content was determined using the Folin–Ciocalteu method, while antioxidant activity was assessed by the DPPH assay. Water-holding capacity (WHC) and oil-holding capacity (OHC) of UBF were also evaluated. Resistant starch content was determined by enzymatic hydrolysis using α-amylase and glucoamylase, followed by centrifugation to separate the resistant starch (sediment) from the digestible fraction (supernatant) for further analysis.

Findings - The total phenolic content of unripe banana flour (UBF) extracted with 80% ethanol was 228 mg GAE/100 g. Antioxidant activity showed an IC_{50} value of 32.02 mg/mL. The water-holding capacity and oil-holding capacity of UBF were 134 g water/100 g UBF and 78.5 g oil/100 g UBF, respectively, indicating its potential to enhance moisture retention, texture, and viscosity in food products. In addition, the resistant starch content of UBF was 36% on a dry weight basis, which can function as a prebiotic substrate for beneficial gut microbiota.

Research limitations - This study is limited by the use of a single in vitro antioxidant assay (DPPH), and further characterization of individual phenolic compounds would provide a more comprehensive understanding of the bioactive profile of UBF.

Originality/value - The findings demonstrate that UBF possesses substantial phenolic content, notable antioxidant activity, and favorable hydration and lipid-binding properties, highlighting its potential as a multifunctional ingredient for food formulation. This work supports the valorization of local banana cultivars and promotes sustainable utilization of agricultural products.

Keywords: unripe bananana flour, Fumcrional ingredient, antioxidant, Functional food, alternative flour

Introduction

linked to food security and agro-based livelihoods

Its high nutritional content and low fat level provide carbohydrates, essential minerals, and vitamins.

Lower risk of chronic diseases such as cardiovascular disorders

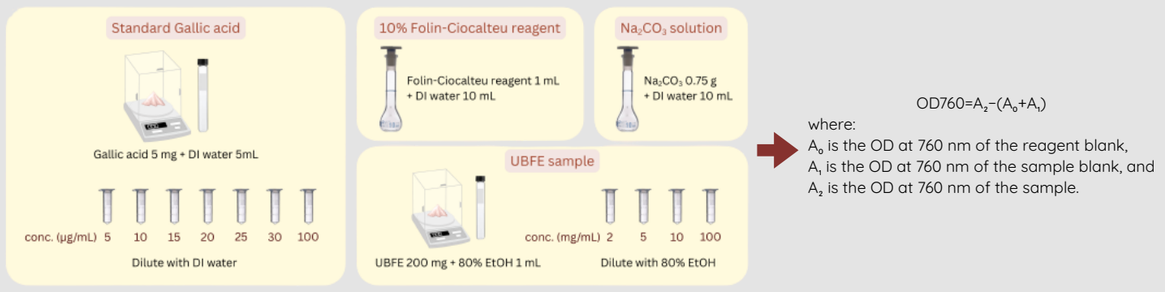
It serves as a natural source of prebiotics, especially fructooligosaccharides (FOS), which are short-chain carbohydrates derived from partial hydrolysis of inulin

Methods

Extraction

40 g of UBF in 80% Ethanol → extraction at 70°C for 4 hr → re-extraction → filtered through Whatman no.1 → evaporated → desiccated overnight → **UBFE**

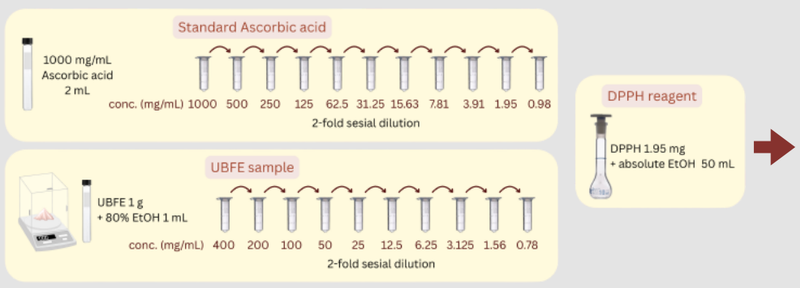
TPC analysis



$$OD760=A_2-(A_0+A_1)$$

where:
A_0 is the OD at 760 nm of the reagent blank,
A_1 is the OD at 760 nm of the sample blank, and
A_2 is the OD at 760 nm of the sample.

DPPH analysis



$$\%inhibition = \frac{A_0 - (A_2 - A_1)}{A_0} \times 100$$

A_0 = OD_{760} of reagent blank
A_1 = OD_{760} of sample blank
A_2 = OD_{760} of sample

Enzymatic hydrolysis for the production of resistant starch

Results

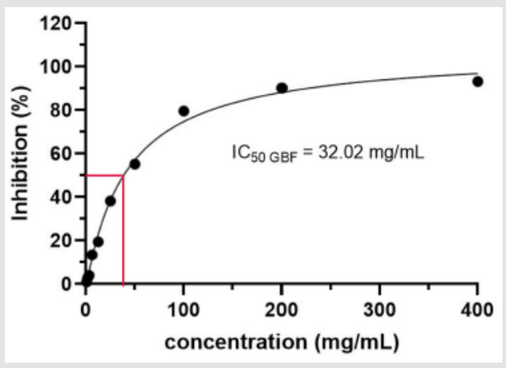


Figure 1. Antioxidant activity of UBFE by DPPH

The total phenolic content of unripe banana flour (UBF) extracted with 80% ethanol was 228 mg GAE/100 g

Antioxidant activity showed an IC_{50} value of 32.02 mg/mL.

The water-holding capacity and oil-holding capacity of UBF were 134 g water/100 g UBF and 78.5 g oil/100 g UBF, respectively

Figure 2. A significant increase in glucose content was observed.

The amount of glucose released during enzymatic hydrolysis reflected the digestible starch fraction of UBF

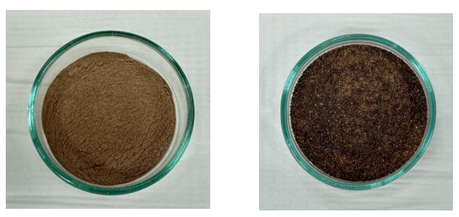


Figure 3. Resistant starch from UBF

The resistant starch content of UBF was 36.0% on a dry weight basis

Discussion

The results indicated that green banana flour exhibited a high water-holding capacity (WHC) of 134 g/100 g sample and an oil-holding capacity (OHC) of 78.5 g/100 g sample, highlighting its strong potential for application in food products that require moisture retention and improved texture, such as bakery and health-oriented foods. In addition, the banana flour extract contained a total phenolic content of 228 mg gallic acid equivalent per extract weight and showed moderate antioxidant activity, with an IC_{50} value of 32.02 mg/mL, suggesting its potential as a natural antioxidant source.

Structural observations revealed that native green banana flour possessed a compact and well-defined crystalline structure with rough surfaces and sharp edges, whereas gelatinized starch exhibited a predominantly amorphous structure. In contrast, resistant starch showed partial crystallinity and increased brittleness, indicating substantial structural rearrangement of starch molecules induced by processing. These structural changes are associated with altered physicochemical behavior and functional properties of the flour. Furthermore, thermal behavior analysis suggested partial recrystallization (retrogradation) in resistant starch, a characteristic feature of enzyme-resistant starch (RS3), which contributes to its enhanced resistance to enzymatic digestion.

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