

PHYSICAL PROPERTIES OF CUPCAKES SUBSTITUTED WITH BANANA FLOUR

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Abstract

Unripe banana flour is considered a resistant starch because it is a type of carbohydrate that resists digestion in the upper gastrointestinal tract. This property allows it to act as a prebiotic, promoting gut health by being fermented in the colon to produce beneficial short-chain fatty acids. The objective of this study was to develop a cupcakes substituted with banana flour. Physical properties of cupcakes substituted with banana flour were evaluated by using texture analyzer and Hunter lab colorimeter. Unripe banana flour from sweet banana grown in Thailand was used to substitute wheat flour at 10-40%. The results indicated that the use of unripe banana flour to substitute wheat flour increased the darkness of cupcakes especially at 30-40%. Hardness of cupcakes substituted at 10% banana flour was slightly decreased from 50 N in cupcake control samples (no banana flour) to 43 N. However, springiness of cupcakes substituted with banana flour at 10% substitution was increased 10.18% compared with control. Sensory evaluation, 9-point hedonic score showed that banana flour substituted at 10% was acceptable at score 7.92 from overall acceptable score.

Keywords: Banana flour, Cupcake, Physical properties, Substitution

Introduction

Namwa banana or sweet banana is a cultural plant that has long been an important part of Thai society. Bananas can grow in tropical climates. Banana is very popular among gardeners found in every region of Thailand. There are 43,878 households of farmers who grow Namwa bananas registered with the Department of Agricultural Extension in Thailand with a planting area of 109,086 rai or 174,538 km². Unripe banana flour is considered a resistant starch. Which is benefit for gut microbiome. Banana flour is made by peeling, slicing, drying green bananas, and grinding the dried slices into a powder.

Cupcake is a small, individually-sized cake baked in a paper or aluminum cup, designed to serve one person. They are made from wheat flour, eggs, milk, baking powder, vegetable oil or butter, food color and flavor. Cupcakes are popular because they are cheap and easily served in casual meetings and homes.

The objective of this research was to utilize banana flour, which was produced from Namwa bananas substituting wheat flour in cupcake products at 10-40% in cupcakes. Moreover, the physical properties of cupcakes substituted with banana flour were determined to compare with control samples.

Research Objectives

1. To substitute wheat flour with banana flour at 10-40% in cupcakes
2. To find the physical properties of cupcakes substituted with banana flour

Scope of the Research

1. Wheat flour substitution with banana flour in cupcakes
2. Physical properties determination
3. Sensory evaluation

Literature Review

Wheat flour bakery has health concerns for celiac customers, affecting 1% of the population (Demirkesen & Ozkaya, 2022; Cabanillas, 2020; Caio et al., 2020). Celiac customers need strictly gluten free products. Partial substituted products in celiac disease refers to foods made with a blend of gluten-free flours, which partially replace wheat-based ingredients to improve texture, flavor, or nutritional value. These products use a mix of gluten-free alternatives like corn, rice, sorghum and banana. Partial substituted wheat products with other flour can reduce the risk of celiac disease. Moreover, partial substituted wheat with chia flour in gluten free noodles increase protein, fat, antioxidant activity and total phenolic content of noodles (Levent, 2017).

Suweeranon et al. (2025) studied quality attributes and sensory characteristics of reduced-caloric muscat cupcakes substituted with banana flour (55, 70, 85 and 100%) and monk fruit extract in order to produce healthy treats. They reported that texture properties of cupcakes substituted with banana flour were significantly different compared with control samples.

Cupcakes mixed with banana flour were darker and have banana scent. However, sensory evaluation results showed cupcakes substituted with banana flour were not significantly different compared with control samples (Suweeranon and et al, 2025).

Research Methodology

1. Banana flour preparation

Unripe bananas were boiled in boiling water for 5 minutes, peeled, cut to thin slides and dried at 50°C for 6 hours. They were ground into the powder and stored in plastic bags at 5°C in a refrigerator. Banana flour is yellowish white powder.

2. Cupcake preparation

The ingredient of cupcakes was composed of wheat flour 29.54%, sugar 16.88%, milk 16.88%, yoghurt 12.66%, soybean oil 12.66%, egg 10.55% and baking powder 0.84%. Wet ingredients were mixed together in an aluminum bowl. Wheat flour and banana flour were weight and mixed with wet ingredients. Cake batter (45 g) was put into a paper cup and baked at 180°C for 20 mins.

3. Color measurement

Cupcakes were put in the plastic bags measured for color parameters (CIE-LAB L*, a*, b*) with a colorimeter (Colorimeter Quest XE., Hunter Lab, USA) by using D65 artificial daylight setting at 10° standard angle and a 25 mm measuring aperture. Before measurement, the equipment was calibrated with a standard white tile. Cupcakes were measure at the top of the samples.

4. Texture Properties

Instron texture analyzer (Lloyd Instruments Ltd, England) was used to determine hardness (N), cohesiveness, and springiness (mm) of cupcakes by using a cylindrical probe (diameter 40 mm) with a compression mode. Test speed was 5 mm/s. Trigger force was 0.001 N. Compression distance was 50% of sample height (30 mm). NEXYGEN software was used

for testing and data analysis. Cupcakes samples were freshly baked and kept in a room temperature at 25°C for 1 hour before measuring texture properties.

5. Sensory Evaluation

The 9-point hedonic scale is used for sensory evaluation by using 20 panelists, age range 18-25 years, to measure consumer liking on cupcakes products on different aspects e.g. texture, color, taste, flavor, and overall acceptance. The 9-point scale provides a range of nine verbal categories, from 1 (dislike extremely) to 9 (like extremely). Samples were identified by using random three numbers.

6. Statistical Analysis

All of the sample analyses were done in triplicate. Statistical analysis was calculated using SPSS v. 22 (SAS Institute Inc. Cary, NC, USA). Duncan was used to find significant differences at a probability level of 5% ($p < 0.05$).

Research Results

The lightness of cupcakes decreased when the percentage of banana flour increased because banana flour was darker than wheat flour and lacks of gluten (Suweeranon et al. (2025), which reduced the volume of the final product. The more banana flour substitution can result in a darker color and a weaker structure, as it introduces less gluten, which impacts the overall structure of the baked good. Springiness of cupcakes was slightly increased at the high amount of banana flour substitution.

Table 1: Color measurement of cupcakes substituted with banana flour at different percentages

Samples	L*	a*	b*
wheat flour	65.54 ± 0.82 ^a	12.02 ± 0.63 ^b	43.03 ± 1.07 ^a
10% banana flour	55.32 ± 0.39 ^b	12.31 ± 0.36 ^{ab}	33.78 ± 0.72 ^b
20% banana flour	54.65 ± 0.30 ^b	12.45 ± 0.28 ^a	31.66 ± 1.46 ^b
30% banana flour	48.63 ± 0.24 ^d	12.74 ± 0.46 ^a	30.22 ± 1.39 ^c
40% banana flour	44.44 ± 0.49 ^d	12.96 ± 0.53 ^a	29.47 ± 0.33 ^c

Table 2: Texture measurement of cupcakes substituted with banana flour at different percentages

Samples	Hardness (N)	Cohesiveness	Springiness (mm)	Adhesiveness (Nmm)
wheat flour	62.04 ± 1.98 ^a	0.25 ± 0.04 ^a	11.40 ± 0.46 ^b	0.43 ± 0.18 ^a
10% banana flour	44.59 ± 3.25 ^b	0.21 ± 0.01 ^a	12.95 ± 0.07 ^a	0.40 ± 0.21 ^a
20% banana flour	43.12 ± 0.16 ^b	0.23 ± 0.01 ^a	12.82 ± 0.19 ^a	0.41 ± 0.16 ^a
30% banana flour	35.23 ± 0.34 ^c	0.24 ± 0.01 ^a	12.56 ± 0.01 ^a	0.45 ± 0.06 ^a
40% banana flour	32.59 ± 5.46 ^b	0.22 ± 0.01 ^a	12.36 ± 0.09 ^a	0.48 ± 0.44 ^a

Sensory evaluation, 9-point hedonic score showed that banana flour substituted at 10% was acceptable at score 7.92 from overall acceptable score. The substitution level of banana flour can be accepted to 20% by considering texture, color and flavor acceptance at 7.44, 7.31, 7.20 respectively. However, the substitution level of banana flour is recommended at 10% considering on the most acceptance of consumers.

Table 3: Sensory evaluation of cupcakes substituted with banana flour at different percentages

Samples	Texture	Color	Flavor	Taste	Overall
wheat flour	7.38 ± 1.4 ^a	7.06 ± 1.2 ^a	7.44 ± 1.1 ^a	7.06 ± 1.8 ^a	7.81 ± 0.9 ^a
10% banana flour	7.63 ± 1.5 ^a	7.69 ± 1.2 ^a	7.50 ± 1.2 ^a	7.31 ± 1.4 ^a	7.92 ± 1.1 ^a
20% banana flour	7.44 ± 1.4 ^a	7.31 ± 1.4 ^a	7.20 ± 1.6 ^a	7.21 ± 1.3 ^a	7.69 ± 1.2 ^a
30% banana flour	6.94 ± 1.2 ^a	6.94 ± 1.3 ^a	6.75 ± 1.1 ^a	6.63 ± 1.2 ^a	7.00 ± 1.0 ^a
40% banana flour	6.56 ± 1.0 ^a	6.63 ± 0.5 ^a	6.19 ± 1.2 ^a	6.38 ± 1.2 ^a	6.75 ± 0.7 ^b

Discussion

From physical properties results and sensory evaluation of cupcake substituted with banana flour at 10-40% in wheat flour. The acceptance level of banana flour substitution is 10%. Hardness of cupcakes decreased by banana flour addition. However, springiness slightly increased when banana flour was added into cupcakes.

Recommendations

1. Scanning Electron Microscopy (SEM) is recommended to do to find microstructure of cupcakes.
2. Proximate analysis is recommended to do to find the nutrition of cupcakes.

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