1. Project name

Gluten-free Functional Breadsticks

2. Research Project Head and Co-researchers

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3. Origin and Significance

Currently, over 1% of the global population experiences gluten intolerance[1]. In addition, health-conscious consumers are increasingly choosing gluten-free products and functional foods. However, gluten-free products often exhibit inferior appearance and texture, leading to low consumer acceptance. Moreover, antioxidants derived from natural sources are highly sensitive to food processing[2]. Therefore, this research aims to develop a gluten-free functional breadstick with characteristics similar to those made from gluten-containing flour. The breadsticks incorporate lycopene, a potent antioxidant, into a complex with rice flour amylose, offering an alternative product for consumers with gluten intolerance and those interested in healthy food options.

4. Technology or Process

The development of gluten-free functional breadsticks uses a gluten-free flour mix, primarily composed of rice and potato flours, fortified with a lycopene-amylose helix inclusion complex (see Figure 1). This complex is synthesized using a supercritical CO_2 technique, where amylose from rice flour encapsulates lycopene within its helix structure. The resulting gluten-free flour demonstrates enhanced antioxidant properties and improved lycopene stability (see Table 1), maintaining its functional integrity throughout the breadstick production process.

5. Highlights or Originality of This Research

This research develops a baked product, specifically breadsticks, using gluten-free flour as the main ingredient, supplemented with a lycopene-amylose helix inclusion complex. The resulting gluten-free product retains physical characteristics comparable to those of wheat-flour-based products while offering enhanced stability of bioactive compounds (see Figures 2 and 3). This innovative product demonstrates superior properties compared to current market alternatives, as no similar gluten-free breadsticks with these enhanced features are currently available.

6.Utilization

The gluten-free flour mix containing the lycopene-amylose helix inclusion complex can be applied to various baked products, providing an alternative for consumers with gluten intolerance and those seeking healthier food options. This innovation adds value to rice flour and gac fruit, both of which are agricultural products of Thailand.

7. Tables and Figures

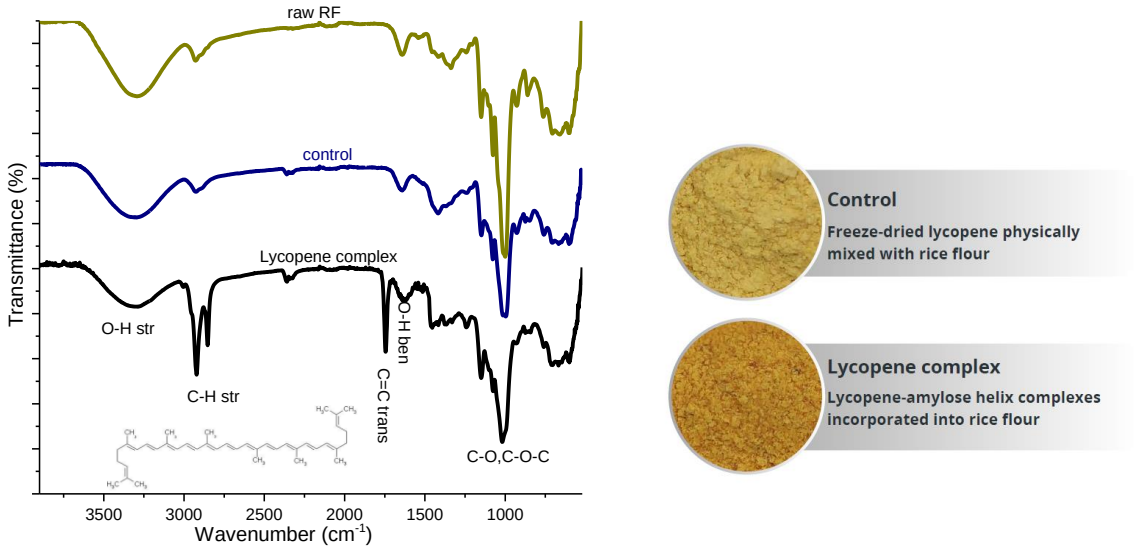

Figure 1 The FTIR spectra illustrate the structural evolution of lycopene in raw rice flour (raw RF), freeze-dried lycopene physically mixed with rice flour (control), and lycopene-amylose helix complexes incorporated into rice flour (lycopene complex).

Table 1 Properties of gluten-free flour and gluten-free functional flour

Properties	Gluten-free flour	Gluten-free functional flour*
Amylose (%)	27.75 ± 0.40	26.74 ± 0.78
Antioxidant activity - DPPF (mmol TE) - FRAP (μmol TE)	 69.70 ± 1.15 27.89 ± 1.65	 74.21 ± 1.02 36.79 ± 1.41
Total polyphenol (mg eq GA/100 g)	28.32 ± 1.00	46.64 ± 1.15
Water solubility index (%)	0.164 ± 0.030	0.087 ± 0.014
Water absorption index	3.13 ± 0.52	2.86 ± 1.08

* Gluten-free functional flour refers to gluten-free flour fortified with a lycopene-amylose helix inclusion complex.

(a)

(b)

Figure 2 Gluten-free functional flour (a) and breadsticks (b)

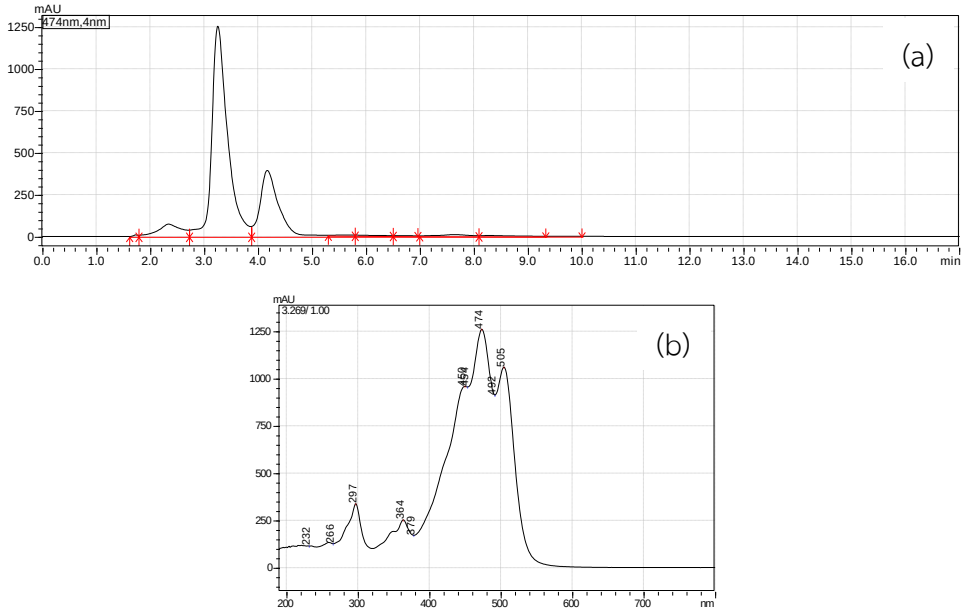

Figure 3 HPLC chromatogram (a) and lycopene absorption spectra (b) of lycopene in gluten-free functional breadsticks

8. Intellectual Property Registration Number

IP provisional of petty patent no. 2303001777: The formula and production process of gluten-free breadsticks fortified with a lycopene-amylose helix inclusion complex

IP provisional of petty patent no. 2303003838: Formulation and process for producing lycopene-encapsulated starch in water-soluble amylose that retains the value of lycopene, using an industrial-scale supercritical carbon dioxide extraction reactor

IP provisional of patent no. 2101003058: Water-soluble and highly stable lycopene-amylose complex and its preparation process

9. Innovation pictures

10. References

[1] Singla, D., Malik, T., Singh, A., Thakur, S., & Kumar, P. (2024). Advances in understanding wheat-related disorders: A comprehensive review on gluten-free products with emphasis on wheat allergy, celiac and non-celiac gluten sensitivit. *Food Chemistry Advances, 4,* 100627.

[2] Toydemir G, Gultekin Subasi B, Hall RD, Beekwilder J, Boyacioglu D, Capanoglu E. (2022). Effect of food processing on antioxidants, their bioavailability and potential relevance to human health. *Food Chem X, 14,* 100334.

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