
Original Article

DPPH RADICAL-SCAVENGING ACTIVITY OF NOODLES, STICKS, AND COOKIES INCORPORATED WITH CLITORIA TERNATEA EXTRACT

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ABSTRACT

Background: Butterfly pea flowers (*Clitoria ternatea* L.) contain bioactive compounds - specifically anthocyanins - that possess antioxidant properties and have potential applications as functional food ingredients. However, different food processing methods can influence the antioxidant activity present in the final product.

Objectives: This study aimed to compare the antioxidant activity of butterfly pea flower extract incorporated into three food products, namely, noodles, sticks, and cookies.

Methods: This study employed a laboratory experimental design to evaluate the antioxidant activity of butterfly pea flower-based food products. Samples of butterfly pea flower noodles, sticks, and cookies were dried, ground into powder, and extracted using methanol. The filtrates were reacted with 2,2-diphenyl-1-picrylhydrazyl (DPPH) solution and incubated for 30 minutes in the dark at room temperature. Antioxidant activity was determined by measuring absorbance at 517 nm using a UV-Visible spectrophotometer and expressed as the percentage of DPPH radical scavenging activity.

Results: Butterfly pea flower sticks exhibited the highest DPPH radical-scavenging activity at 10.46%, followed by cookies at 8.66% and dried noodles at 3.94%. The results indicate differences in DPPH radical-scavenging activity among the three food products, which may be associated with differences in formulation, food matrix, processing conditions, and extraction efficiency.

Conclusion: Among the tested products, butterfly pea flower sticks demonstrated the highest DPPH radical-scavenging activity. The findings indicate that product type and processing conditions may influence the retention and measurable activity of bioactive compounds from butterfly pea flower. However, the observed antioxidant activities were relatively low and should be interpreted within the specific testing conditions. Further research using multiple sample concentrations is recommended to determine the concentration-response relationship and IC₅₀ value.

Keywords: Antioxidant Activity, Butterfly Pea Flower, *Clitoria Ternatea*, DPPH, Functional Food.

INTRODUCTION

Butterfly pea (*Clitoria ternatea* L.) is a plant that has attracted increasing interest as a potential functional food ingredient because of its natural bioactive compounds, particularly anthocyanins. The characteristic blue color of butterfly pea flowers is primarily associated with

polyacylated anthocyanins, which are known to possess antioxidant properties. The presence of these compounds makes butterfly pea a potential natural source of antioxidants that can be incorporated into various food products. In addition to providing natural color, the incorporation of butterfly pea extract into food products may contribute to the bioactive properties of the resulting products (Chandrajith et al., 2021).

Antioxidant activity is an important characteristic of food products containing plant-derived bioactive compounds because antioxidants can react with free radicals and reduce their potential oxidative effects. The antioxidant potential of butterfly pea has been reported in several studies and is associated with its phenolic compounds and anthocyanin content. However, the antioxidant activity of plant-based ingredients may change during food processing. Anthocyanins are relatively sensitive to processing conditions, and factors such as temperature, processing time, pH, and exposure to oxygen may influence their stability. Therefore, the antioxidant activity of butterfly pea extract in the final food product cannot be assumed to be identical to that of the raw extract (Munteanu & Apetrei, 2021).

Food processing conditions are particularly important when butterfly pea extract is incorporated into products with different processing methods. Noodles, sticks, and cookies have different food matrices and undergo different processing conditions. Noodle production generally involves mixing, dough formation, shaping, and cooking, while sticks commonly undergo frying at relatively high temperatures. Cookies, on the other hand, are generally subjected to baking. Differences in temperature, processing duration, moisture content, and food composition may influence the stability of anthocyanins and consequently affect the antioxidant activity of the final products. Therefore, evaluating antioxidant activity after processing is important to determine whether the bioactive properties of butterfly pea are retained in different food matrices (Munteanu & Apetrei, 2021).

The DPPH (2,2-diphenyl-1-picrylhydrazyl) radical-scavenging assay is commonly used to evaluate the ability of a sample to scavenge free radicals. The method is based on the reduction of the stable DPPH radical by antioxidant compounds, which results in a decrease in absorbance. The antioxidant activity can subsequently be expressed as the percentage of DPPH radical-scavenging activity. In the present study, this parameter is used to evaluate the antioxidant potential of food products containing butterfly pea extract. Therefore, the term “DPPH radical-scavenging activity” is more appropriate than the general term “antioxidant value” for describing the measured outcome (Hadirama et al., 2024).

Previous research has demonstrated the antioxidant potential of butterfly pea flowers and the bioactive compounds they contain. However, most studies have focused on butterfly pea flower extracts or specific food products, while comparative information regarding DPPH radical scavenging activity across various food matrices remains limited. In particular, the influence of different processing characteristics—such as those involved in making noodles, sticks, and cookies—on the DPPH radical scavenging activity of products containing butterfly pea flower extract has not been adequately investigated. Comparing these three products is important because differences in formulation and processing methods can result in varying levels of antioxidant compound retention or degradation (Shiau et al., 2024).

Therefore, this study was conducted to evaluate and compare the DPPH radical scavenging activity of noodles, sticks, and cookies enriched with butterfly pea flower (*Clitoria ternatea* L.) extract. The study is expected to provide information regarding the potential of

butterfly pea flower extract as a functional food ingredient, as well as the influence of different food matrices and processing methods on the antioxidant activity of the resulting products.

METHODS

Study Design

This study employed a laboratory experimental design to evaluate and compare the DPPH radical-scavenging activity of three food products incorporated with butterfly pea (*Clitoria ternatea* L.) flower powder: noodles, sticks, and cookies. The experimental procedure consisted of food-product preparation, sample drying and homogenization, methanolic extraction, reaction with DPPH solution, incubation, and measurement of absorbance using a UV-Visible spectrophotometer. The antioxidant outcome was expressed as the percentage of DPPH radical-scavenging activity.

Settings

The study was conducted as a laboratory-based experiment involving the preparation of butterfly pea flower-based food products and subsequent antioxidant analysis using the DPPH assay.

Research Subject

The research subjects were three types of butterfly pea flower-based food products, namely dried noodles, sticks, and cookies. The products were prepared using butterfly pea flower powder incorporated into their respective food formulations. The main formulations included 5 g of butterfly pea flower powder for sticks, 15 g for cookies, and 5 g for noodles.

The study therefore did not involve human participants or animal subjects. The experimental units consisted of the prepared food-product samples that were subsequently analyzed for DPPH radical-scavenging activity.

Intervention/ Experimental Procedure

The intervention in this laboratory experiment was the incorporation of butterfly pea flower powder into three different food matrices, namely sticks, cookies, and noodles, followed by antioxidant testing.

For the butterfly pea flower sticks, the formulation consisted of 150 g wheat flour, 50 g tapioca flour, and 5 g butterfly pea flower powder as the principal dry ingredients. The butterfly pea flower powder represented 2.44% of the total dry ingredients.

For the cookies, the formulation included 600 g low-protein wheat flour, 60 g skim milk, 15 g butterfly pea flower powder, 300 g margarine, 150 g powdered sugar, and 6 egg yolks.

For the noodles, the formulation consisted of wheat flour, tapioca flour, butterfly pea flower powder, eggs, salt, cooking oil, and water. The butterfly pea flower powder was incorporated at 5 g in the reported formulation.

After the food products were prepared, each product was dried and ground into powder. More than 1 g of each powdered sample was mixed with 1 mL methanol and filtered to obtain the sample filtrate. Subsequently, 1 mL of the filtrate was mixed with 1 mL DPPH solution. The mixture was incubated for 30 minutes in the dark at room temperature, after which absorbance was measured at 517 nm using a UV-Visible spectrophotometer.

Instruments

The laboratory equipment included an analytical balance, blender, oven, water bath, UV-Visible spectrophotometer, graduated cylinders, Erlenmeyer flasks, volumetric pipettes, and test

tubes. The analytical balance was used for accurate weighing of materials, while the blender was used to homogenize samples. The oven was used for drying, and the water bath was used for controlled heating. The UV-Visible spectrophotometer was used to measure sample absorbance. Graduated cylinders, Erlenmeyer flasks, volumetric pipettes, and test tubes were used for preparation, mixing, measurement, and reaction of the samples.

The principal analytical reagents reported in the manuscript were methanol and DPPH (2,2-diphenyl-1-picrylhydrazyl) solution.

Data Collection

Data were collected through laboratory measurement of the absorbance of the three butterfly pea flower-based food products following the DPPH assay procedure. For each product, the powdered sample was extracted with methanol, filtered, reacted with DPPH solution, and incubated for 30 minutes in the dark at room temperature. Absorbance was subsequently measured at a wavelength of 517 nm using a UV-Visible spectrophotometer.

The recorded measurements included the absorbance of the control and the absorbance of each sample. The reported control absorbance was 0.889, while the sample absorbance values were 0.812 for cookies, 0.796 for sticks, and 0.854 for dried noodles. These measurements were used to determine the percentage of DPPH radical-scavenging activity.

Data Analysis

DPPH radical-scavenging activity was calculated from the absorbance measurements and expressed as a percentage. The study used the DPPH method to assess the ability of the samples to reduce the DPPH radical, as reflected by the decrease in absorbance following reaction with the sample.

The antioxidant activity obtained for each product was then compared descriptively across the three food matrices. The reported DPPH radical-scavenging activity was 10.46% for sticks, 8.66% for cookies, and 3.94% for dried noodles.

Ethical Considerations

This study was a laboratory experiment involving food-product samples and chemical analysis and did not involve human participants, patient data, or animal subjects. Therefore, procedures related to informed consent, human-subject recruitment, and protection of participant confidentiality were not applicable.

RESULTS

DPPH Radical-Scavenging Activity

The DPPH radical-scavenging activity of the three-butterfly pea (*Clitoria ternatea* L.) flower-based food products was assessed based on the reduction in absorbance following reaction with DPPH solution. The control absorbance was 0.889. Among the three products, the butterfly pea flower sticks showed the highest DPPH radical-scavenging activity, followed by cookies and dried noodles.

The absorbance of the stick sample was 0.796, corresponding to a DPPH radical-scavenging activity of 10.46%. The cookie sample had an absorbance of 0.812 and a DPPH radical-scavenging activity of 8.66%, whereas the dried noodle sample showed an absorbance of 0.854 and a DPPH radical-scavenging activity of 3.94%.

Comparison of DPPH Radical-Scavenging Activity among Products

The results demonstrated variation in DPPH radical-scavenging activity among the three food products. The activity of the sticks was 1.80 percentage points higher than that of the cookies and 6.52 percentage points higher than that of the dried noodles. The cookie activity was 4.72 percentage points higher than that of the dried noodles.

Table 1. DPPH Radical-Scavenging Activity of Butterfly Pea Flower-Based Food Products.

Food product	Control absorbance	Sample absorbance	DPPH radical-scavenging activity (%)
Cookies	0.889	0.812	8.66
Sticks	0.889	0.796	10.46
Dried noodles	0.889	0.854	3.94

The highest measured DPPH radical-scavenging activity was observed in the butterfly pea flower sticks (10.46%), while the lowest was observed in the dried noodles (3.94%). Cookies showed an intermediate activity of 8.66%. Overall, all three products demonstrated measurable DPPH radical-scavenging activity under the experimental conditions used.

DISCUSSION

The present study demonstrated differences in DPPH radical-scavenging activity among butterfly pea (*Clitoria ternatea* L.) flower-based sticks, cookies, and dried noodles. The highest activity was observed in the sticks (10.46%), followed by cookies (8.66%) and dried noodles (3.94%). These findings indicate that the antioxidant activity measurable by the DPPH assay varied according to the type of food product in which butterfly pea flower was incorporated.

The measurable DPPH radical-scavenging activity observed in all three products is consistent with the presence of bioactive compounds in butterfly pea flowers, particularly anthocyanins and other phenolic compounds. Previous research has described *Clitoria ternatea* as a source of anthocyanins with antioxidant properties, although the stability and measurable activity of these compounds can be affected by processing conditions and the food matrix. Chandrajith et al. (2021) reported that anthocyanins in butterfly pea flowers are associated with antioxidant activity, while Munteanu and Apetrei (2021) emphasized that antioxidant activity can be affected by factors such as temperature, processing time, pH, oxygen exposure, and other analytical conditions.

The higher DPPH radical-scavenging activity observed in the sticks compared with cookies and dried noodles may be related to differences in formulation and processing. The sticks had a measured activity of 10.46%, compared with 8.66% in cookies and 3.94% in dried noodles. The relatively higher value in the sticks may reflect differences in the composition of the product matrix and the processing conditions used during preparation. However, this interpretation should be considered cautiously because the present study did not independently evaluate the contribution of individual ingredients or measure changes in anthocyanin concentration during processing.

The processing characteristics of the three products differed substantially. The products underwent different preparation and processing procedures, resulting in different food matrices. Such differences can influence the stability and extraction of antioxidant compounds. Previous literature has indicated that anthocyanins may be sensitive to thermal processing and other environmental conditions. Shiao et al. (2024), for example, reported that phytochemical characteristics, antioxidant activity, and thermal stability are important considerations when evaluating *Clitoria ternatea* flower extracts. Therefore, the differences observed in the present study may reflect the combined effects of formulation, processing conditions, and the final food matrix rather than a single processing factor.

The higher activity observed in the sticks should not, however, be interpreted as evidence that frying itself increased antioxidant activity. Although frying can reduce moisture and potentially concentrate compounds within a food matrix, moisture content was not measured in this study. In addition, the stick formulation contained other ingredients, including garlic and cheese, whose individual contributions to DPPH radical-scavenging activity were not separately assessed. Consequently, the observed activity cannot be attributed specifically to butterfly pea flower or to the frying process alone.

The relatively low activity observed in the dried noodles may similarly be associated with differences in formulation, processing, and food matrix. However, the present study did not measure anthocyanin degradation, compound leaching, moisture content, or extraction recovery. Thus, these factors remain possible explanations rather than confirmed mechanisms. The lower measured activity should therefore be interpreted as a finding under the specific experimental conditions rather than as evidence that noodles inherently have lower antioxidant potential than other butterfly pea-based food products.

An important consideration in interpreting the findings is the analytical concentration used in the DPPH assay. The study employed a single sample concentration, and therefore the results provide information on DPPH radical-scavenging activity under the tested conditions but do not establish a concentration-response relationship. Previous studies have demonstrated antioxidant activity of *Clitoria ternatea* extracts, but direct comparison among studies requires consideration of differences in sample concentration, extraction solvent, reaction conditions, and analytical procedures.

The use of a single concentration also prevented determination of the IC₅₀ value. An IC₅₀ represents the concentration required to achieve 50% radical-scavenging activity and is commonly used to characterize antioxidant potency when an appropriate concentration-response curve is available. Because only one concentration was evaluated in the present study, the relative DPPH activity values should not be interpreted as IC₅₀-based measures of antioxidant potency. Future studies should evaluate several sample concentrations to construct a concentration-response curve and determine IC₅₀ values.

The findings have potential relevance for the development of butterfly pea-based functional food products because the incorporation of *Clitoria ternatea* provides measurable radical-scavenging activity in different food matrices. Nevertheless, the relatively low DPPH activity values observed in this study indicate that the findings should be interpreted within the specific experimental conditions and should not alone be used to establish a health benefit or strong functional-food effect. Additional analyses of anthocyanin and phenolic contents,

moisture, processing stability, and antioxidant activity at multiple concentrations would provide a more comprehensive assessment of the functional properties of these products.

Overall, the present findings suggest that butterfly pea flower-based food products can exhibit measurable DPPH radical-scavenging activity, but the magnitude of activity differs among product types. The differences are likely to reflect the combined influence of formulation, processing conditions, food matrix, and extraction characteristics. Further research using standardized formulations, multiple sample concentrations, replicate measurements, and additional antioxidant and phytochemical analyses is needed to clarify the factors responsible for the differences in antioxidant activity among butterfly pea-based food products.

CONCLUSION

Based on the results of antioxidant activity testing using the DPPH method, it can be concluded that stick products have the highest antioxidant activity compared to cookies and dry noodles. The antioxidant activity values were 10.46% for sticks, 8.66% for cookies, and 3.94% for dry noodles, respectively. This difference indicates that product type and processing method influence the product's ability to scavenge DPPH free radicals.

SUGGESTION

The butterfly pea flower sticks exhibit in vitro DPPH radical scavenging activity that can be measured under the specified testing conditions. because they maintain higher antioxidant activity than cookies and dry noodles. Therefore, the development of butterfly pea flower-based stick products has greater potential for use as functional snacks with antioxidant benefits.

LIMITATIONS

The different processing methods for each product are thought to affect the stability and concentration of bioactive compounds, particularly anthocyanins from butterfly pea flowers.

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