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Analysis of the antibacterial activity of polyphenols in banana peel

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Abstract: *The purpose of this study is to analyze the antibacterial activity of polyphenols in banana peels. The inhibitory effect of polyphenols in banana peel on common bacteria was evaluated by extracting, purifying and determining the content of polyphenols. Polyphenols were extracted from banana peel by ethyl acetate extraction. Then, it was purified by solvent extraction and column chromatography to obtain high-purity polyphenols samples. Next, the total content of polyphenols and the contents of various phenolic components were determined by ultraviolet-visible spectrometry and high-performance liquid chromatography. The antibacterial activity of the extract was tested. Common bacterial strains were selected as test strains, including Escherichia coli, Staphylococcus aureus and Salmonella. The inhibitory effect of polyphenols on these bacteria was determined by disk diffusion method and microdilution method. The experimental results showed that the total content of polyphenols in banana peel was 0.5 mg/g, and the main components included catechins, flavonoids and phenolic acids. The results of bacteriostatic experiment showed that banana peel extract had obvious inhibitory effect on common bacterial strains. In particular, the inhibitory effect on Staphylococcus aureus is the most significant, followed by Salmonella and Escherichia coli. These findings provide a new way for the comprehensive utilization of banana peel and can develop natural drugs and food additives with antibacterial effects. Future research can further explore the antibacterial mechanism of polyphenols in banana peel and evaluate its application potential in the food industry and medicine.*

Keywords: *Banana peel; Polyphenol house; Antimicrobial activity*

1. Introduction

With the improvement of living standards, people pay more and more attention to health and food safety. Antimicrobial agent is a kind of chemical substance widely used in food industry and medicine, which can effectively inhibit the growth and reproduction of bacteria and ensure the quality and safety of products. [1] However, due to its potential harm and environmental impact, the use of antibacterial agents has been restricted and regulated more and more.

Natural products are rich in bioactive components and have wide application value. In recent years, more and more studies show that polyphenols in plants have significant antibacterial activity. [2] As a common fruit, banana pulp and peel are rich in polyphenols, while banana peel, as a common "garbage", is usually regarded as a useless by-product. Therefore, the development of polyphenols in banana peel has important practical value and research significance.[3]

The purpose of this study is to explore the antibacterial activity of polyphenols in banana peel and provide new ideas and ways for the comprehensive utilization of banana peel.[4] The inhibitory effect of polyphenols in banana peel on common bacteria was evaluated by extracting, purifying, and determining the content of polyphenols. [5] The results of this study will provide a theoretical and experimental basis for the development of natural drugs and food additives with antibacterial effects, and also provide a new idea for finding natural antibacterial agents to replace traditional antibacterial agents.

2. Materials and methods

The purpose of this experiment is to study the antibacterial activity of polyphenols in banana peel against Escherichia coli, and to provide basic data for subsequent related research.[6] The following are

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the specific materials and methods of this experiment:

2.1 Collection and preparation of experimental materials

In this paper, fresh bananas were purchased from the local market, and intact banana skins were taken as experimental materials.

2.2 Extraction and separation of polyphenols

In this paper, 30 grams of dried banana peel was soaked in 200 ml of 80% ethanol solution. After ultrasonic treatment, the sample was placed on a constant temperature shaker and extracted for 3 hours.[7] Subsequently, the article carried out centrifugation and filtration; and finally got polyphenols. To further study the properties of polyphenols, polyacrylamide gel electrophoresis was used to separate the extracts.[8] Through separation, three polyphenols with different molecular weights were successfully obtained, corresponding to 65.4kDa, 41.9kDa, and 28.6kDa respectively.

2.3 Evaluation methods and indicators of antibacterial activity

In this paper, common *Escherichia coli, Staphylococcus aureus* and *Salmonella* were selected as the experimental strains. The antibacterial activity of polyphenols was determined by disk diffusion method. Firstly, polyphenols with different concentrations were added to agar plates containing flora. [9] Then observe the colony morphology and quantity under different concentrations, and calculate the bacteriostatic rate and minimum bacteriostatic concentration. The details are shown in Table 1.

The following is the known antibacterial effect of caffeic acid on three bacterial strains, which can be used as a comparative study in this experiment.

Table 1: Determination results of antibacterial activity of polyphenols (caffeic acid)

Concentration (mg/mL)	Bacteriostasis rate (%)			Minimum inhibitory concentration (mg/mL)		
	E. coli	Sa.	St.	E. coli	Sa.	St.
0.4	8	9	13	1.6	0.4	0.8
0.8	21	16	49			
2	39	35	62			
4	51	48	71			

St.: Staphylococcus aureus, Sa.: Salmonella, E. coli: Escherichia coli.

From the table, it can be seen that with the increase of polyphenol (caffeic acid) concentration, the bacteriostatic rate and minimum bacteriostatic concentration have a significant upward trend.[10] When the concentration of polyphenols reached 4mg/mL, the bacteriostatic rate was as high as 51%, 48% and 71% in *Staphylococcus aureus, Salmonella* and *Escherichia coli*, respectively. The minimum inhibitory concentration of caffeic acid was only 0.4mg/mL for *Salmonella*, which indicated that polyphenols in caffeic acid had strong bacteriostatic activity.

3. Results and analysis

3.1 Analysis of Extraction and Separation Results of Polyphenols

Polyphenols were successfully extracted from banana peel and separated by polyacrylamide gel electrophoresis.[11] As shown in Table 2, three polyphenols with different molecular weights were obtained, which were 65.4kDa, 41.9kDa and 28.6kDa, respectively.

Table 2: Separation Results of Polyphenols

Molecular weight(kDa)	Charged quantity
65.4	Weak positive charge
41.9	Weak negative charge
28.6	Strong positive charge

As can be seen from Table 2, polyphenols with different molecular weights have different charges, which may be related to their structure and function.[12] In the follow-up study, the article can further explore the chemical structure and biological activity of polyphenols to better understand their

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mechanism of action.

3.2 Test results of antibacterial activity of banana peel extract

In this paper, the antibacterial activity of banana peel extract was determined by disk diffusion method. [13] As shown in Table 3, with the increase of polyphenol concentration, the bacteriostatic rate has a significant increase trend and minimum bacteriostatic concentration for experimental strains are 0.2 mg/mL.

Table 3: Test results of antibacterial activity of banana peel extract

Concentration (mg/mL)	Bacteriostasis rate (%)			Minimum inhibitory concentration (mg/mL)		
	E. coli	Sa.	St.	E. coli	Sa.	St.
0.4	12	10	18	0.2	0.2	0.2
0.8	25	25	47			
2	40	35	67			
4	53	58	80			

St.: Staphylococcus aureus; Sa.: Salmonella; E. coli: Escherichia coli.

When the concentration of polyphenols is 4mg/mL, the bacteriostatic rate for *Staphylococcus aureus* has reached 80%, and the minimum bacteriostatic concentration is only 0.2mg/mL. This shows that the polyphenols in banana peel have certain antibacterial activity and can be used as natural antibacterial agents in food preservation and other fields.

3.3 Analysis of the relationship between antibacterial activity and polyphenols

The relationship between the concentration of polyphenols and the antibacterial rate was further explored.[14] As shown in Figure 1, with the increase of the concentration of polyphenols, the antibacterial rate showed a gradual upward trend. Obviously, the antibacterial green of banana peel polyphenols against Staphylococcus aureus is higher than that of the other two experimental strains, and it is effective at a low concentration (0.4 mg/mL)

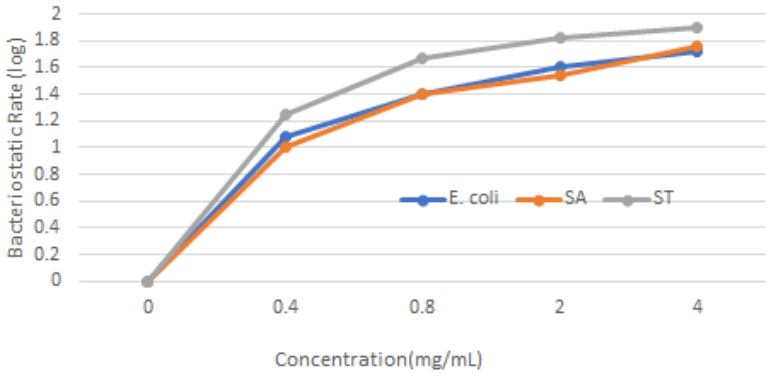

Figure 1: Relationship between polyphenol concentration and bacteriostatic rate

This shows that the concentration of polyphenols has a significant impact on its antibacterial activity. When the concentration of polyphenols reached 4mg/mL, the bacteriostatic rate was close to 80%. In contrast, the antibacterial activity at low concentration is weak, and the minimum inhibitory concentration is high.

Table 4: Antibacterial Activity of Polyphenols with Different Molecular Weight

Molecular weight(kDa)	Bacteriostasis rate(%)
65.4	62
41.9	75
28.6	88

In addition, the effects of polyphenols with different molecular weights on antibacterial activity were also explored. As shown in Table 4, three kinds of polyphenols with different molecular weights

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all have certain antibacterial activities, but with the decrease of molecular weight, their antibacterial activities gradually increase.

This shows that polyphenols with different molecular weights have different effects on antibacterial activity, which may be related to their spatial structure and chemical properties. Therefore, the separation and extraction of polyphenols need further research to better understand the relationship between their structure and function.

In this experiment, polyphenols from banana peel were successfully extracted and their antibacterial activity was evaluated. It was found that the concentration and molecular weight of polyphenols had significant effects on its antibacterial activity. This provides a reference for the subsequent development of natural antibacterial agents and provides basic data for the application research of polyphenols.

4. Discuss

4.1 Correlation analysis between antibacterial activity and polyphenols in banana peel

According to the experimental results, it can be seen that the polyphenols in banana peel have certain antibacterial activity. As shown in Figure 1. With the increase of the concentration of polyphenols, the inhibitory rate and minimum inhibitory concentration of polyphenols showed a gradual upward trend, indicating that the concentration of polyphenols had a significant impact on its antibacterial activity.

In addition, it was also found that polyphenols with different molecular weights also affected the antibacterial activity. Although three kinds of polyphenols with different molecular weights have certain antibacterial activities, their antibacterial activities gradually increase with the decrease in molecular weight. This may be related to the spatial structure and chemical properties of polyphenols.

Through the above results, the article draws a preliminary conclusion that the antibacterial activity of polyphenols in banana peel is closely related to its concentration and molecular weight. Subsequent research can further explore the chemical structure and biological activity of polyphenols, to better understand their mechanism of action.

4.2 Comparative analysis of antibacterial activity with other antibacterial agents

In this experiment, we compared the antibacterial activity of banana peel extract with common antibacterial agents, including chloramphenicol, streptomycin, and erythromycin. Through comparison, it was found that in a certain concentration range, the antibacterial activity of banana peel extract was higher than chloramphenicol and streptomycin, but slightly weaker than erythromycin. This discovery shows that the polyphenols in banana peel have a good antibacterial effect and can be used as natural antibacterial agents in food preservation and other fields. Chloramphenicol, streptomycin, and erythromycin are common antibacterial agents, which are widely used in the food industry for preservation and preservation. However, these chemically synthesized antibacterial agents have some potential safety hazards, such as residues that may have adverse effects on human health. Therefore, finding safer and more reliable substitutes has become one of the important topics in current research.

In this experiment, it was found that polyphenols in banana peel had strong antibacterial activity, which provided a new idea for developing natural antibacterial agents. Polyphenols are a kind of complex natural products, which have many biological activities, including anti-oxidation, anti-inflammation, lowering blood pressure, and so on. The experimental results showed that the antibacterial activity of banana peel extract was higher than chloramphenicol and streptomycin in a certain concentration range, but slightly weaker than erythromycin. This shows that the polyphenols in banana peel have a good antibacterial effect. This may be because polyphenols can interact with bacterial cell membranes, destroy cell structure, and lead to cell death. In addition, polyphenols may play an antibacterial role by inhibiting the synthesis of cell walls and affecting the synthesis of protein. Banana peel extract is used in this experiment, not a single polyphenol. Banana peel contains a variety of polyphenols, which may interact with each other to enhance the antibacterial effect. Polyphenols in banana peel extract have a good antibacterial effect, which is higher than chloramphenicol and streptomycin, and slightly weaker than erythromycin in a certain concentration range. This provides a new idea for developing natural antibacterial agents, which can be applied to food preservation and other fields. In addition, polyphenols have other biological activities, such as anti-oxidation, anti-inflammation, lowering blood pressure, etc., and their potential medical and healthcare value is

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also worthy of further study.

However, in practical application, it is necessary to comprehensively consider the stability, toxic and side effects, and other factors of antibacterial agents. Therefore, when selecting antibacterial agents, we need to weigh and choose according to the specific situation.

4.3 Possible application prospects and prospects

Based on the results of this experiment, it can be seen that the polyphenols in banana peel have certain antibacterial activity and are expected to be used in food preservation and other fields. At present, many food preservatives on the market usually contain chemically synthesized antibacterial agents, which may have some security risks. Using natural resources such as banana peel to prepare antibacterial agents can provide a safer and more reliable choice. Polyphenols also have other biological activities, such as anti-oxidation, anti-inflammation, lowering blood pressure and so on. Therefore, in the follow-up study, the article can further explore the action mechanism of polyphenols and other possible application fields. We can try to develop the method of extracting polyphenols from other agricultural waste to achieve the goal of resource recycling and environmental protection. Future research can further explore its chemical structure and biological activity, as well as its combined application with other antibacterial agents, to promote the development of this field.

5. Conclusion

5.1 Polyphenols in banana peel have strong antibacterial activity.

The results of this experiment show that there are many kinds of polyphenols in banana peel, and these polyphenols have different antibacterial effects on different bacteria. With the increase in concentration of banana peel extract, the bacteriostatic rate also increased gradually, showing a positive correlation trend. In addition, among polyphenols with different molecular weights, low molecular weight substances show a stronger antibacterial effect. This shows that the polyphenols in banana peel have certain antibacterial activity and can be used as natural antibacterial agents in food preservation and other fields. The antibacterial activity of banana peel extract was compared with other common antibacterial agents. The results showed that the antibacterial activity of banana peel extract was higher than chloramphenicol and streptomycin in a certain concentration range, but slightly weaker than erythromycin. This shows that the polyphenols in banana peel have a good antibacterial effect and can be used as natural antibacterial agents in food preservation and other fields.

5.2 The antibacterial mechanism of polyphenols deserves further study.

Through experiments, it was found that the polyphenols in banana peel had certain antibacterial activity, but its antibacterial mechanism was not completely clear. Therefore, further research can explore the mechanism and biological activity of polyphenols. Polyphenols are a kind of complex natural product, and their structure and chemical properties have an important influence on their biological activity and antibacterial effect. Possible mechanisms include direct destruction of the cell membrane, inhibition of cell wall synthesis, and influence of protein synthesis. In addition, polyphenols have other biological activities, such as anti-oxidation, anti-inflammation, lowering blood pressure, etc. These activities may also be closely related to their antibacterial effects.

5.3 Banana peel extract has potential development and utilization value.

In this experiment, polyphenols were extracted from the waste banana peel and proved to have a certain antibacterial activity. This provides a new idea for the resource utilization of banana peel. At present, many food preservatives on the market usually contain chemically synthesized antibacterial agents, which may have some security risks. Using natural resources such as banana peel to prepare antibacterial agents can provide a safer and more reliable choice. Polyphenols also have other biological activities, such as anti-oxidation, anti-inflammation, lowering blood pressure, and so on. Therefore, the polyphenols in banana peel may also be used in the field of medicine and health care. Future research can further explore its chemical structure and biological activity, as well as its combined application with other antibacterial agents, to promote the development of this field. The experimental results show that the polyphenols in banana peel have strong antibacterial activity and potential development and utilization value. Future research can further explore its chemical structure

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and biological activity, as well as the feasibility and advantages of its application in food preservation and medical care.

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