基于紫玉米芯的光热杀菌膜的构建及其在圣女果保鲜中的应用

Development of a Photothermal Antibacterial Film using Purple Corncob Anthocyanin and Its Application in Cherry Tomato Preservation

团队成员：许苑，石新悦，王江玥，薛若榆　　指导老师：刘夫国

西北农林科技大学　食品科学与工程学院

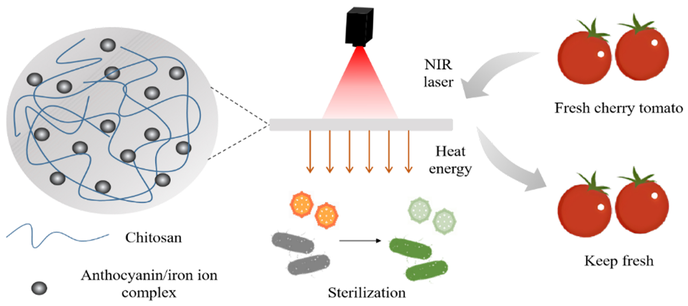
Introduction

The contamination of foodborne pathogens is a growing global food safety problem that poses a serious threat to people's lives and health. For this reason, many food sterilization methods have been developed, among which pasteurization is the most widely used sterilization technique, which meets the market demand and maintains the " freshness " characteristics of food while ensuring food safety. However, conventional pasteurization still has some inherent limitations, including the need for liquid media and the reliance on external heat sources.

Using photothermal packaging films , the heating temperature, processing time, sterilization efficiency and application limitations of traditional pasteurization can be changed while improving the antimicrobial capacity of the packaging films.

Anthocyanins can combine with metal ions to form complexes , which sometimes have photothermal conversion effects. In this research, chitosan was selected as the film matrix. Anthocyanins extracted from purple corn cobs and then co-doped with iron ions were used as photothermal materials. In addition, fruit preservation experiments were conducted using cherry tomatoes as an experimental fruit to explore the preservation effects of the photothermal sterilization films.

Materials and Methods



Results and Discussion

Anthocyanin/metal ion complex

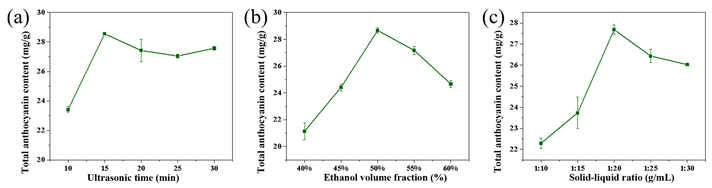


Fig. 1 (a) Influence of ultrasonic time, (b) ethanol volume fraction and (c) solid-liquid ratio on anthocyanin content in PCCE (P<0.05).

Results and Discussion

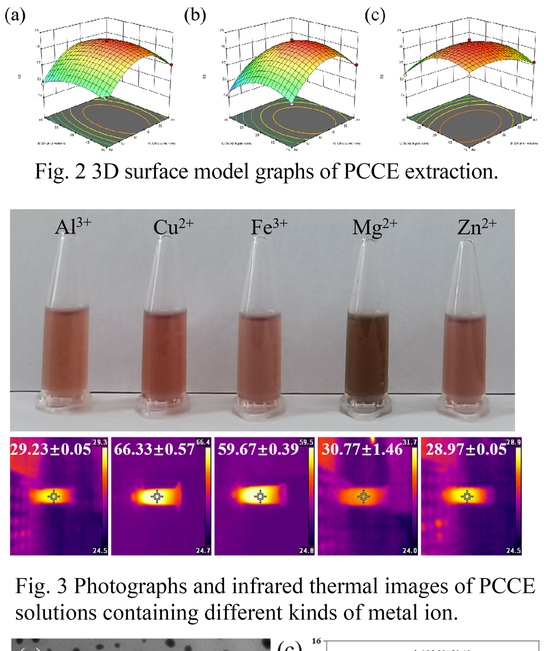


Fig. 2 3D surface model graphs of PCCE extraction.

Fig. 3 Photographs and infrared thermal images of PCCE solutions containing different kinds of metal ion.

Fig. 4 Characterization of PCCE/Fe complex. (a) TEM images of PCCE/Fe complex; (b) SEM image of PCCE/Fe complex; (c) Particle size distribution of PCCE/Fe complex; (d) Zeta potentials of CS, PCCE, Fe, PCCE/Fe and CS-PCCE/Fe solutions.

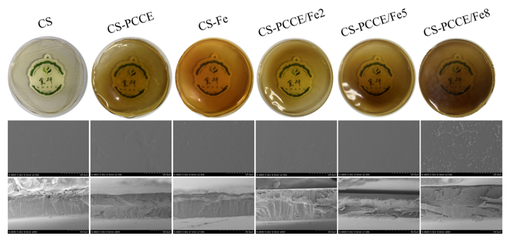


Fig. 5 Optical photographs of CS, CS-PCCE and CS-PCCE/Fe films with different concentrations (top row) and SEM images of the surfaces and cross sections of these films (bottom row).

Photothermal properties

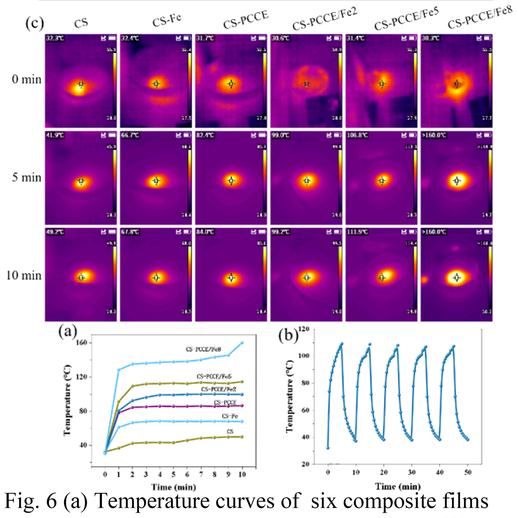


Fig. 6 (a) Temperature curves of six composite films under different irradiation times (0-10 min) at 2 W/cm^2; (b) Temperature rise and cooling curves of CS-PCCE/Fe under repeated switching of NIR laser; (c) Infrared thermal images of six composite films before and after exposure to NIR light (808 nm, 2 W/cm^2).

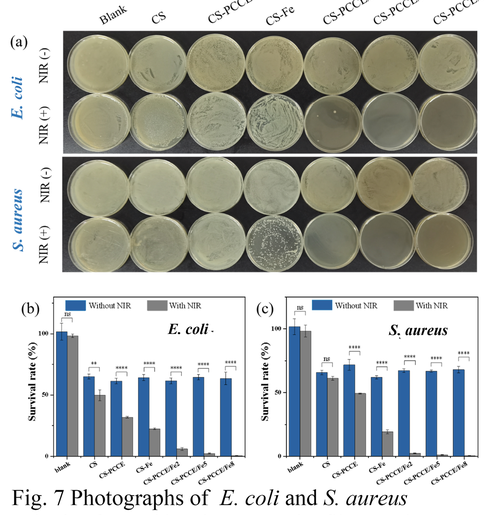


Fig. 7 Photographs of *E. coli* and *S. aureus* colonies formed by six composite films under near infrared irradiation and non-near infrared irradiation, respectively, and relative survival rates of corresponding *E. coli* and *S. aureus*.

Basic properties

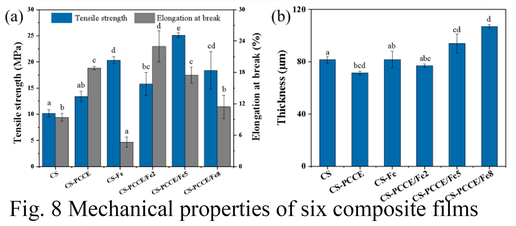


Fig. 8 Mechanical properties of six composite films with different concentrations. (a) Tensile strength and elongation at break of films; (b) Thickness of films.

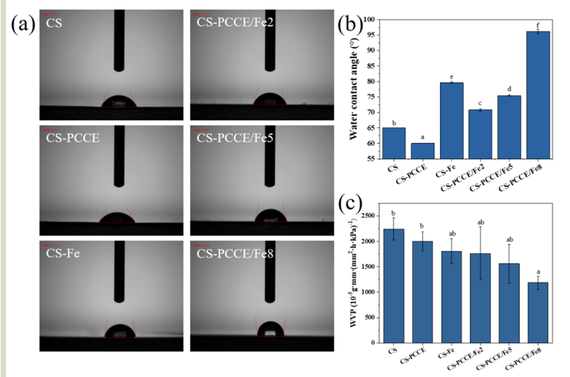


Fig. 9 Properties of six composite films with different compositions: (a) Images of water contact angles; (b) Water contact angle statistics; (c) Water vapor permeability.

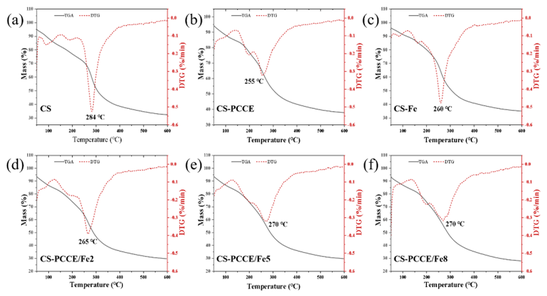


Fig. 10 Thermal stability of (a) CS film, (b) CS-PCCE film, (c) CS-Fe film, (d) CS-PCCE/Fe2 film, (e) CS-PCCE/Fe5 film and (f) CS-PCCE/Fe8 film.

Application

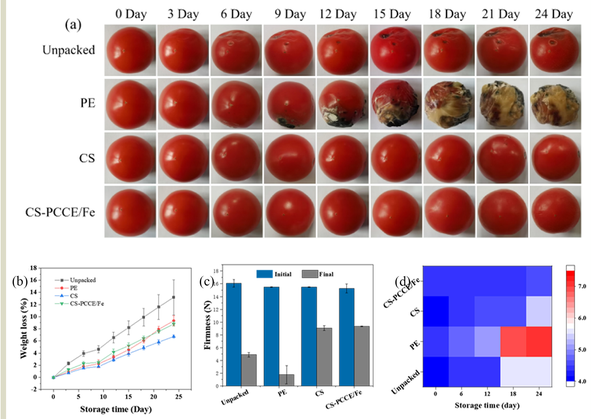


Fig. 11 (a) Pictures of cherry tomatoes with different treatments (bare fruit, PE, CS and CS-PCCE/Fe films) during storage time; (b) Weight loss; (c) Hardness changes and (d) pH Changes of cherry tomatoes under different treatments (bare fruit, PE, CS and CS-PCCE/Fe films) during storage (0-25 days).

Achievements

[发明公布] 一种光热杀菌膜及其制备方法和应用

申请公布号：CN116874841A　申请公布日：2023.10.13

申请号：202310769496　申请日：2023.06.27

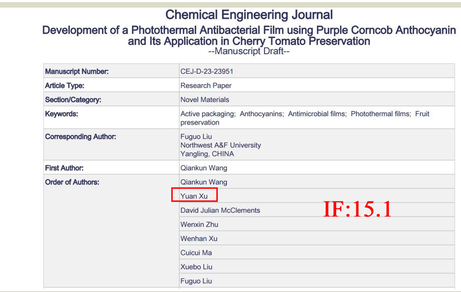
申请人：西北农林科技大学　发明人：刘夫国; 收起

王乾坤 许苑 薛若榆 马翠荣 刘学波

地址：712000陕西省咸阳市杨凌示范区邰城路3号

分类号：C08J5/18(2006.01)I; 全部

摘要：本发明提供了一种光热杀菌膜及其制备方法和应用，所述方法包括通过乙醇和水混合溶剂提取含花青素的紫玉米芯提取物(PCCE)，之后与铁离子(Fe3+)、壳聚糖(CS)混合加入增塑剂制得成膜液；其中，PCCE与铁离子进行络合反应，形成PCCE/Fe络合物，壳聚糖与所述PCCE/Fe络合物通过分子间作用力，形成具有CS-PCCE/Fe结构的分子络合物的成膜液，将所述成膜液倒在模具上烘干得到光热杀菌膜。本发明提供的光热杀菌膜，不仅适用于液体，还可以用于固体食品的杀菌，且不需要大型仪器设备即可实现与巴氏杀菌类似的杀菌效果，使用方便、制备原料来源广泛，廉价环保，制备方法简单，易推广。本发明提供的光热杀菌膜能够应用在食品包装领域。收起



Chemical Engineering Journal

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--Manuscript Draft--

Manuscript Number:	CEJ-D-23-23951
Article Type:	Research Paper
Section/Category:	Novel Materials
Keywords:	Active packaging; Anthocyanins; Antimicrobial films; Photothermal films; Fruit preservation
Corresponding Author:	Fuguo Liu Northwest A&F University Yangling, CHINA
First Author:	Qiankun Wang
Order of Authors:	Qiankun Wang
	Yuan Xu
	David Julian McClements
	Wenxin Zhu
	Wenhan Xu
	Cuicui Ma
	Xuebo Liu
	Fuguo Liu

IF:15.1

Conclusion

1.The composite films exhibited strong photothermal properties and high bactericidal activity against both Gram-positive and Gram-negative bacteria in an *in vitro* bactericidal test.

2.The addition of anthocyanins and iron ions improved the hydrophobicity, thermal stability, and tensile strength of the chitosan film.

3.The composite films prolonged the shelf life of cherry tomatoes during storage.

E-mail:yuanxu020222@163.com