

EFFECTS OF ULTRASONIC-ASSISTED EXTRACTION PROCESS ON THE TOTAL POLYPHENOL AND VITAMIN C CONTENT FROM JAMBOLAN

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ABSTRACT:

This study determines the appropriate conditions for the extraction of polyphenol compounds and vitamin C from Jambolan with the use of the ultrasonic-assisted extraction (UAE) method. The study analyzes three factors of the UAE method, namely: the ratio of raw material to solvent (w/v), the ultrasonic power (W), and the processing time (minutes). Experiments show that the extraction gains the highest total polyphenol content when the ratio of raw material to solvent is 1:25 w/v, the microwave power is 275 W, and the processing time is 6 minutes. Jambolan contains many compounds with high biological activity that can be used in food, pharmaceuticals, and medicine.

Keywords: total polyphenol content (TPC), vitamin C, Jambolan, Ultrasonic Assisted Extraction (UAE).

1. Introduction

Jambolan (*Syzygium cumini*) is one of the widely used medicinal plants in the treatment of various diseases and it shows significant pharmacological actions. The genus *Syzygium* is one of the genera of the myrtle family *Myrtaceae* which is native to the tropics [1].

Jambolan is a great source of vitamin C, carbohydrates, and minerals. It also contains biological phenolic compounds such as anthocyanin, gallic acid, and tannin. [2] Antioxidant properties from total polyphenol

content (TPC) and vitamin C in Jambolan have pharmacological roles in human health.

Extraction is the process of selectively dissolving one or more components present in a sample of raw materials by exposing the material to a solvent. The driving force of the extraction process is the difference in the concentration of the constituents in the material and in the solvent [3]. Currently, there are many methods to extract biologically active compounds from plants, in which ultrasonic extraction is one of the potential technologies for exploiting beneficial bioactive compounds in raw materials.

The purpose of this study is to investigate the influence of ultrasound-assisted extraction conditions such as solvent ratio, ultrasonic power, and extraction time on TPC and vitamin C of Jambolan fruit extracts, creating a premise for the process of obtaining vitamin C and TPC effectively thereafter applying them in food.

2. Materials and methods

This research was carried out in the laboratory of the Faculty of Food Technology, Hochiminh City University of Food Industry.

2.1. Materials

Chemicals: gallic acid, Na_2CO_3 , KI, HCl, KIO_3 made in China, purity 99%, and Folin - Ciocalteu made in Germany. The reagents and solvents used in this study were of analytical grade.

Materials: The Jambolan fruit was purchased locally in An Giang province.

2.2. Sample treatment

Jambolan fruit was sorted to remove the contaminations (unripe fruit, damaged fruit, dirt, etc.), then it was washed and ground with a blender and thoroughly mixed. The obtained sample was divided evenly into jars for each time of testing.

1g of prepared Jambolan fruit sample was added to distilled water (1/50, w/v). The mixture was incubated in the thermostatic bath to extract for 2 hours. The collected filtrate was volumed up to 100ml in a brown volumetric flask to prepare for the determination of TPC and vitamin C.

2.3. Ultrasound-assisted treatment of the sample

1g of prepared Jambolan fruit sample was added to distilled water with a ratio of material and examined solvent (1/10, 1/15, 1/20, 1/25, 1/30 (w/v), ultrasonic power (175W, 200W, 225W, 250W, 275W, 300W), ultrasonic duration (2 minutes, 4 minutes, 6 minutes, 8 minutes, 10 minutes). The filtrate after extraction was vacuum filtered and volumetric in a 100ml brown volumetric flask to prepare for determination of TPC and vitamin C.

2.4. Determination of TPC

The TPC was determined using the Folin-Ciocalteu reagent method. Folin-Ciocalteu reagent (5mL), and Na_2CO_3 saturated solution (4mL) were added in turn to test tubes containing 1ml of diluted extract and shaken by Vortex for 5-10s. Sealed and protected from light, incubated in the dark for 30 minutes at ambient temperature, then measured color absorbance at wavelength $\lambda = 765 \text{ nm}$. The TPC in the extract was determined using a gallic acid standard curve, expressed in milligrams of gallic acid equivalent (GAE) per gram of dry matter.

2.5. Identify the content of vitamin C

The diluted extract sample was accurately measured 50ml in a conical flask. Afterward, 1ml KI 10% solution, 1ml 1M HCl solution, 5 drops of 0.5% starch paste was mixed in order to that conical flask and shake well. The sample was titrated with the prepared 0.002M KIO_3 solution and the color transition was observed. When all the ascorbic acid has been oxidized, the excess iodine will react with the starch indicator, forming a blue-black starch iodide complex. This is the endpoint of the titration.

2.6. Data analysis

In this study, each experiment was performed with three replicates. The obtained results are presented as the mean of three replicates.

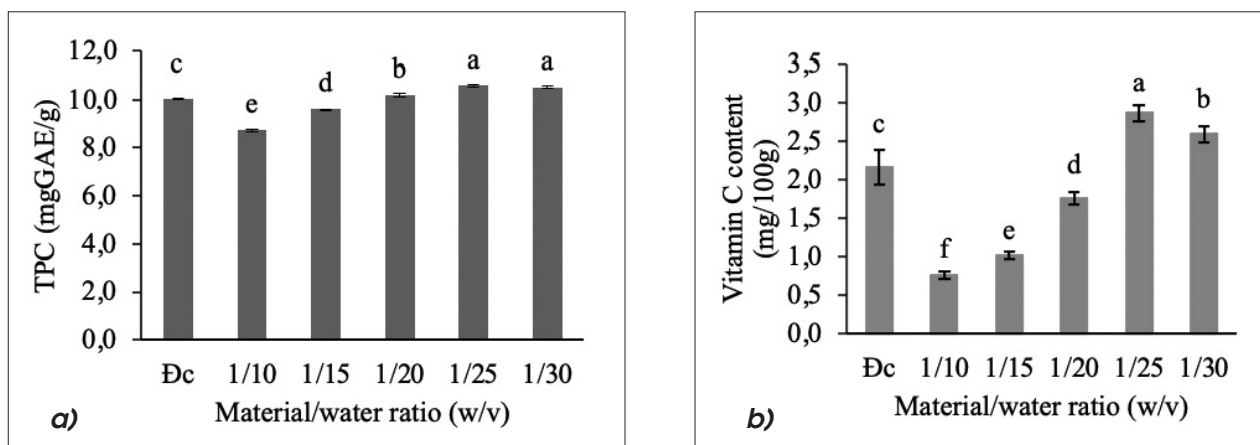
To evaluate the significant difference between the experimental samples, the results were processed by the statistical method ANOVA ($\alpha = 5\%$) on Statgraphics Centurion XVI software. Graphs were drawn by using Microsoft Office Excel 2010 software.

3. Results and discussion

3.1. Investigate the effect of material/solvent ratio on TPC and vitamin C content

Figure 1. showed the highest content of TPC and vitamin C was at the ratio of 1/25 (w/v) ($10,586 \pm 0.051 \text{ mg GAE/g}$, $2,871 \pm 0.106 \text{ mg/100g}$, respectively). When the raw material/solvent ratio was increased to 1/30 (w/v), the TPC is not statistically significant and the

Figure 1. Effect of material/solvent ratio a) on TPC (mg GAE/g) and b) on vitamin C content (mg/100g)



Symbols a, b, c,... represent for statistically significant differences ($p < 0.05$)

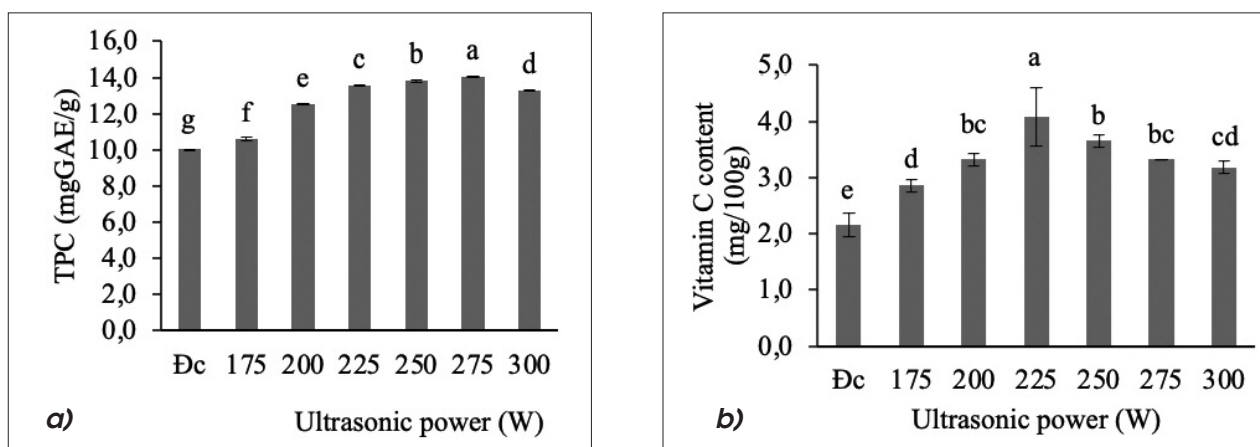
vitamin C content tends to decrease by 10% compared to the ratio of 1/25 (w/v). the more water is added, the higher the kinetics of the process will be, the easier it is for vitamin C to diffuse from the fruit cells to the outside of the solvent and the higher the content of vitamin C obtained. However, when extracting solvent excessively, while the TPC and vitamin C of the materials is fixed therefore the balance between the phases is quickly achieved, leading to inefficient extraction of TPC and vitamin C [4]. The most appropriate ratio of material/solvent to extract TPC and vitamin C was 1/25 (w/v) and the

recovery efficiency reached 50.45% and 25.32%, respectively.

3.2. Investigate the effect of ultrasonic power on the content of TPC and vitamin

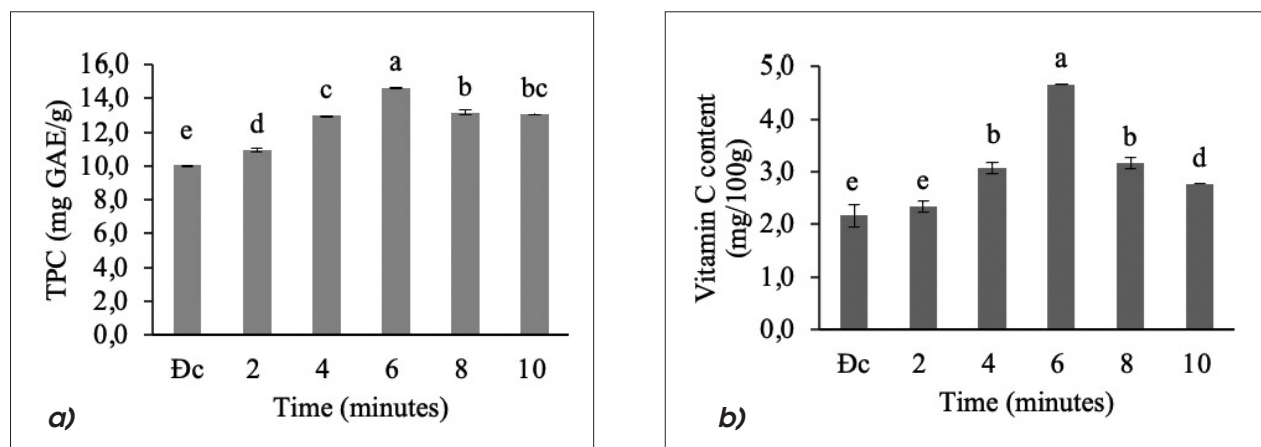
The experimental results from Figure 2. showed that ultrasonic power had a positive effect on the extraction of TPC and vitamin C from Jambolan. By increasing ultrasonic treatment power from 175 to 275W, the TPC has increased 1.3 times from $10,633 \pm 0.101$ mg GAE /g to $14,078 \pm 0.013$ mg GAE/g and the vitamin C content increased from $2,868 \pm 0.106$ mg/100g to $4,093 \pm 0.516$ mg/100g. This is explained by the

Figure 2. Effect of ultrasonic power on a) TPC (mg GAE/g) and b) vitamin C (mg/100g)



Symbols a, b, c,... represent for statistically significant differences ($p < 0.05$)

Figure 3. Effect of ultrasound time on a) TPC (mg GAE/g) and on vitamin C content (mg/100g)



Symbols a, b, c,... represent for statistically significant differences ($p < 0.05$)

fact that the generated ultrasonic waves affect cell wall breaking, facilitating the release of TPC compounds in the cytoplasm. On the other hand, the phenomenon of gas cavitation also allows the solvent penetrates deeply into the material, improving mass transfer, and convection, and promoting diffusion, contributing to an increase in the content of the compound extracted. However, high-power ultrasonic increases the temperature in the solvent and generates free radicals, TPC compounds are oxidized by these free radicals, thereby reducing the obtained TPC. In the case of vitamin C, during ultrasonic processing, the formation, growth, and rupture of small air bubbles cause fluctuations in pressure in the environment. The phenomenon of gas cavitation promotes the breakdown of fruit cell tissue and cell wall structure, enhancing mass transmission [5] [6]. When the ultrasonic power continued to increase from 275 to 300W, the vitamin C content was only $3,186 \pm 0.113$ mg/100g. The highest TPC and vitamin C in Jambolan extract after ultrasonic treatment with a power of 275W was 29% and 35% higher than the control sample, with the recovery efficiency reaching nearly 67.09% and 29.36%, respectively.

3.3. Investigate the effect of ultrasonic time on TPC and vitamin C content

With a processing time of 6 minutes, Figure 3.

showed a TPC of $14,591 \pm 0.034$ mg GAE/g, 1.45 times higher than the non-supersonic control sample. Vitamin C content tends to increase 1.9 times (from 2,339 to 4,654 mg/100g) with the ultrasonic time from 2 minutes to 6 minutes. It is suggested that when ultrasonic processing takes a longer time, based on the air penetration phenomenon the transformation of the raw materials will be stronger and the cell disruption process happens thoroughly. However, when the time increased from 6 to 10 minutes, the TPC decreased to $13,075 \pm 0.041$ mg GAE/g and the vitamin C content decreased to 2,765 mg/100g. The reason is when the ultrasound time is prolonged, more free radicals are generated, some TPC compounds in the extract are changed and the extraction efficiency is also reduced [7]. Thus, the appropriate time for the extraction of TPC and vitamin C is 6 minutes. The recovery efficiency of TPC and vitamin C was 69.53% and 41.40%, respectively.

4. Conclusion

The study investigates the effect of ultrasonic extraction conditions on TPC and vitamin C of Jambolan including material/solvent ratio (1/25) at 60°C, ultrasonic power (275W), extraction time (6 minutes), with the above parameters, the TPC and vitamin C content from the extract of Jambolan was the highest ■

REFERENCES:

1. Ayyanar, Muniappan, and Pandurangan Subash-Babu (2012). *Syzygium cumini* (L.) Skeels: A review of its phytochemical constituents and traditional uses. *Asian Pacific journal of tropical biomedicine*, 240-246.
2. A. Banerjee, N. Dasgupta, and B. De. (2005). In vitro study of antioxidant activity of *Syzygium cumini* fruit. *Food Chemistry*, 727-733.
3. Lê Văn Việt Mẫn. (2011). *Công nghệ chế biến thực phẩm*. NXB Đại học Quốc gia Thành phố Hồ Chí Minh.
4. Đ. X. Cường, V. N. B. Lê Tuấn Anh, Bùi Minh Lý (2014). Thu nhận TPC từ cây ngô. *Tạp chí Khoa học - Công nghệ Thủy sản*, 16-21.
5. M. Toma, M. Vinatoru, L. Paniwnyk, and T. J. Mason (2001). Investigation of the effects of ultrasound on vegetal tissues during solvent extraction. *Ultrasonics sonochemistry*, 137-142.
6. J. Wu, L. Lin, and F.-t. Chau (2001). Ultrasound-assisted extraction of ginseng saponins from ginseng roots and cultured ginseng cells. *Ultrasonics sonochemistry*, 347-352.
7. P. Wanasundara, F. Shahidi, and V. Shukla (1997). Endogenous antioxidants from oilseeds and edible oils. *Food Reviews International*, 225-292.

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ẢNH HƯỞNG CỦA QUÁ TRÌNH TRÍCH LY DƯỚI SỰ HỖ TRỢ CỦA SÓNG SIÊU ÂM ĐẾN HÀM LƯỢNG POLYPHENOL VÀ VITAMIN C CÓ TRONG QUẢ TRÂM

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TÓM TẮT:

Nghiên cứu này nhằm xác định điều kiện thích hợp cho quá trình trích ly các hợp chất polyphenol và vitamin C từ quả Trâm thông qua phương pháp trích ly có hỗ trợ sóng siêu âm. Nghiên cứu tiến hành khảo sát 3 yếu tố của phương pháp trích ly có hỗ trợ sóng siêu âm, gồm: tỷ lệ nguyên liệu/dung môi (w/v), công suất sóng siêu âm (W) và thời gian vi sóng (phút). Kết quả nghiên cứu cho thấy, hàm lượng polyphenol tổng đạt được cao nhất khi tỷ lệ nguyên liệu/ dung môi là 1/25 w/v, công suất sóng siêu âm 275W, và thời gian xử lý 6 phút. Quả Trâm có chứa nhiều hợp chất có hoạt tính sinh học cao, có thể ứng dụng trong thực phẩm, dược phẩm và Y học.

Từ khóa: hàm lượng polyphenol tổng, vitamin C, quả Trâm, trích ly có hỗ trợ sóng siêu âm.