RESEARCH ON EXTRACTION TECHNOLOGY TO IMPROVE YIELD AND QUALITY OF OIL FROM GAC ARIL (*MOMORDICA COCHINCHINENSIS SPRENG L.*)

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1. INTRODUCTION

Gac (*Momordica cochinchinensis Spreng* L.) belonging to the family *Cucurbitaceae* is an indigenous Vietnamese fruit-bearing plant. Its fruit flesh contains 1 - 3 mm thick, red, soft, and sticky aril, which covers black seeds and makes up about 25% of the fruit weight [1].

Figure 1. Gac fruit and dried Gac aril

Gac aril has an oil content of about 38% - 40% (as related to absolute dry matter). This oil is a rich source of beta-caroten and lycopen, containing 128 mg%, and 170 mg% of each, respectively. The alpha-tocopherol content in the pulp was found to be 76.3 µg/g [2]. Because of its valuable constituents as mentioned above, Gac fruit oil is studied and used to create functional food and pharmaceutical products.

A 30-day controlled supplementation trial carried out in Vietnam found that daily consumption of ‘‘*xoi gac*’’, a traditional Vietnamese sticky rice dish containing Gac aril, significantly improved plasma levels of retinol, alpha-caroten, beta-caroten, and lycopen in pre-school children [3]. Researchers also investigated the potential of Gac fruit to prevent and treat cancers and vitamin A deficiency, where by juice extracted from dried Gac was found to reduce the tumour weights in mice by 23.6% [4]. The content of lycopen in Gac pulp as reported by this study (408 µg/g) is much higher than that usually found in tomatoes (about 25 µg/g) [5].

Currently, Gac aril oil production is mainly carried out by traditional mechanical expression with a screw press, but this method gives low yield and quality (especially in regard to the content of beta-caroten and lycopen). This paper describes a new method to obtain Gac aril oil with high extraction yield and oil quality.

2. MATERIALS AND METHODS

Dried Gac arils were purchased from Hai Duong pharmaceutical joint stock Company, stored in a freezer (-20^{o}C) and thawed out before use. All solvents and reagents were of purity needed for each application and used without further purification.

Extraction of Gac aril oil was carried out using an IKA magnetic stirrer (controlled speed and temperature) and n-hexane as extraction solvent.

Beta-caroten was analyzed by HPLC (RP 18 column 250 mm × 4 mm, 5 μm; UV-VIS detector at 454 nm; v = 10 μl).

The determination of fatty acid composition was carried out following the method described by AOCS Ce1e-91. An HP gas chromatograph (5890 series II) equipped with flame ionization detector was used. Methyl esters of fatty acids were analyzed on a CPSIL capillary column (25 m, 0.25 mm internal diameter, 0.2 μm film thickness). The oven temperature was programmed from 100 to 150^{o}C at 4.8^{o}C/min, then from 150 to 170^{o}C at 1^{o}C/min and then held at 170^{o}C for 10 min.

3. RESULTS AND DISCUSSION

3.1. Effect of particle size

This experiment shows Gac oil extraction yield obtained for five different particle sizes at the same extraction conditions. The yields were found to increase with decreasing particle size, but when the particle size is very small, the filtration will be difficult. The recommended particle size for Gac oil extraction is therefore 3 mm.

3.2. Influence of number of extractions and ratio of Gac arils to n-hexane

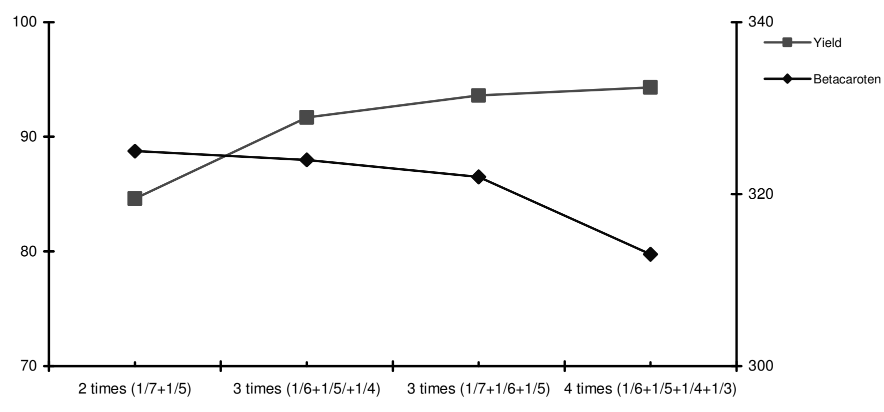

Figure 2. Effect of numbers of extractions and solvent amount on the extraction yield and beta-caroten content

Experiments were carried out at different number of extractions (2, 3, and 4) and ratio of Gac arils raw material to n-hexane (1 : 3, 1 : 4, 1 : 5, 1 : 6, and 1 : 7) to determine the optimum number of extractions and amount of n-hexane. Figure 2 shows that the extraction yield increased markedly with higher number of extractions. For economic reason, we choose 3 as the appropriate number of extractions and the ratio of Gac aril to n-hexane for each extraction is 1/7, 1/6, and 1/5, respectively.

3.3. Effect of extraction temperature

To determine the influence of temperature, experiments were carried out in which the temperature was varied from 30 to 60^{o}C. The results indicate that yield increases with rising temperature, but beta-caroten content is decreased because beta-caroten is very sensitive to high temperature. Therefore, the suitable temperature for extracting Gac aril oil is 50^{o}C.

3.4. Effect of speed of stirring

From the results of these experiments it was apparent that the oil quality and the yield increased markedly when stirring speed is increased up to 250 r/m. Stirring speed of 300 r/m or above will hinder the filtering process because small particles are generated.

3.5. Effect of extraction time

The yield of Gac aril oil increases with increasing extraction time. When total time of extraction reaches above 18 h the quantity of Gac aril oil obtained is not increased significantly. Optimal duration for Gac oil extraction was found to be 7 h for the first extraction, 6 h for the second extraction, and 5 h for the third extraction.

The advantage of n-hexane solvent extraction in the production of Gac aril oil as compared to conventional pressing is an increased oil yield (96.4%, compared with 72.5% as by traditional screw pressing). The acid and peroxide value of Gac aril oil were found to be 4.8 mgKOH/g and 5.4 meqO_2/kg, respectively.

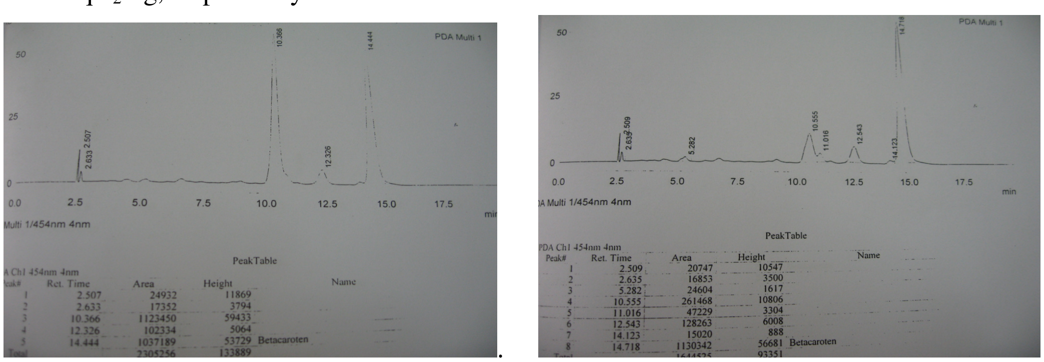

Figure 3. HPLC profile of beta-caroten in Gac aril oil extracted by n-hexane and by screw pressing

The obtained Gac aril oil has been analyzed by HPLC for beta-caroten content and by GC-MS for fatty acids composition. The HPLC results are shown in Figure 3, which compares the contents of beta-carotene in Gac aril oil products from extraction and expression. The content of beta-carotene in Gac aril oil product from solvent extraction (320 mg%) was significantly higher than that from mechanical expression (193 mg%).

Fatty acid composition of Gac aril oil products was shown in Figure 4 and Table 1. The main fatty acids of the Gac aril oil are oleic acid (49.57%) and linoleic acid (23.19%).

Table 1. Fatty acid composition of Gac aril oil

N^0	Fatty acid	% in oil
1	Myristic ($C_{14:0}$)	0.21
2	Palmitic ($C_{16:0}$)	20.27
3	Palmitoleic ($C_{16:1}$)	0.23
4	Margaric ($C_{17:0}$)	0.23
5	Stearic ($C_{18:0}$)	5.35
6	Oleic ($C_{18:1}$)	49.57
7	Linoleic ($C_{18:2}$)	23.19
8	Linolenic ($C_{18:3}$)	0.94

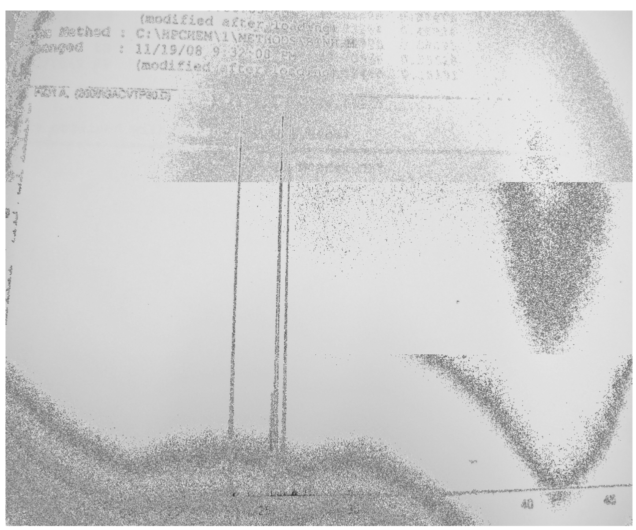

Figure 4. GC-MS profile of fatty acids in Gac aril oil

4. CONCLUSIONS

A new and efficient solvent extraction method for obtaining oil from the fruit aril of the Vietnamese plant *M. cochinchinensis* (Gac fruit) has been developed. The obtaining oil yield and the content of beta-carotene in Gac aril oil product from extraction were 96.4% and 320 mg%, respectively, which were significantly higher than those from mechanical expression (72.5% and 193 mg%).

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TÓM TẮT

NGHIÊN CỨU CÔNG NGHỆ TRÍCH LI ĐỂ NÂNG CAO HIỆU SUẤT VÀ CHẤT LƯỢNG DẦU MÀNG GẤC *(MOMORDICA COCHINCHINENSIS SPRENG* L.)

Dầu màng gấc có hàm lượng lycopen và beta-caroten cao. Đây là các carotenoids rất cần thiết vì chúng là những chất chống oxy hóa tự nhiên, có khả năng ngăn ngừa và hỗ trợ điều trị phòng chống ung thư. Phương pháp truyền thống để khai thác dầu màng gấc là phương pháp ép bằng máy ép trục vít. Phương pháp ép có hiệu suất thấp, dầu thu được có chất lượng không cao (hàm lượng beta-caroten và lycopen thấp). Do đó chúng tôi tiến hành nghiên cứu công nghệ khai thác dầu màng gấc bằng phương pháp trích li dung môi n-hexane. Ảnh hưởng của các thông số của quá trình trích li như: kích thước nguyên liệu, số lần trích li, tir lệ màng gấc/dung môi, nhiệt độ và thời gian trích li… đến hiệu suất và chất lượng dầu màng gấc đã được nghiên cứu. Kết quả nghiên cứu cho thấy ưu điểm của phương pháp trích li so với phương pháp ép truyền thống là hiệu suất khai thác dầu màng gấc đạt 96,4%; hàm lượng beta-caroten đạt 320 mg% (cao hơn gấp 3 lần so với Dược điển). Chỉ số axit và peroxyt của dầu màng gấc thu được bằng phương pháp trích li bằng dung môi n-hexane lần lượt là: 4,8 mgKOH/gam dầu và 5,4 meqO_2/kg dầu.

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