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Research article

Pretreatment method for the protection and maintenance of total carotenoid in Gac (*Momordica cochinchinensis* Spreng) seed membrane

Le Khac Lam Dien[a], Nguyen Phuoc Minh[a], Dong Thi Anh Dao[a]

[a]University of Technology - Vietnam National University - HCMC, Vietnam

*Contact person: Dr Nguyen Phuoc Minh
E-mail: dr.nguyenphuocminh@gmail.com

ABSTRACT

Availability of gac fruit is seasonal. The gac fruit is only available three months out of the year. In Vietnam, gac vines are grown mainly in the red river delta areas. Harvesting of the fruits start on September and lasts until December. Gac fruits are picked when they are at optimal size, weight, and color. Poor post-harvest handling and transportation reduce the shelf-life of the fruit. After harvesting, without proper storage, fruits perish quickly and lose market ability after one week. In the markets of urban areas, gac fruits are available for only about 3 months, from November to January. Gac fruit, Momordica cochinchinensis Spreng contains extraordinarily high levels of carotenoids, especially β-carotene and lycopene, and a comparatively high content of α-tocopherol (vitamin E) and of polyunsaturated fatty acids. The aim of this study is therefore to develop an understanding of suitable conditions for the processing of Gac fruit, with three pretreatment methods: blanching, blanching in citric acid solution and steaming. The result shows that steaming in 6 minutes is the best pretreatment method for the protection and maintenance of total carotenoid content in gac powder.

Key words: Gac fruit, carotenoid, blanching, steaming

INTRODUCTION

In Vietnam, the gac vine is often seen growing on lattices at the entrances of rural homes. The Vietnamese use the seed membranes and the pulp of the fruit in the preparation of "xoi gac". Fruits of Momordica cochinchinensis are big, denselyaculaeate, green in color and when ripe, become dark orange or red. Unlike the bitter gourd (Momordica Charantia), the exocarp (rind) of the gac fruit is hard, and covered with conical points one eighth inch high. There are two shapes of gac fruit available in Vietnam, oblong and almost round, however there are no differences in the ways the fruits are used or consumed. There are also variations among different fruits with respect to their spine and fruit tips. In some fruits, the spines are smooth and dense, whereas insome, they are hard and thinly arranged. The oblong types are 6-10cm in length and round types are 4-6 cm in length. In Vietnam, the oblong fruit weighs between 500g and 1600g and can be 10 to 13 cm long.

Unlike bitter gourd, which is mostly harvested in the developmental stages, gac fruits in Vietnam are only picked at maturity when the fruit is bright red and seeds are hardened. The mesocarp of the momordica cochinchinensis (gac) fruit is 1/2" thick, spongy and orange in color. The core is divided into cartilaginous chambers containing bright red fleshy seed pods. Each fruit has on average between 15 to 20 seeds. Seed are round, compressed and sculptured. The average weight of the pulp is about 19% of the total fruit weight. An average gacfruit weighing 1kg yields approximately 190g of fruit pulp and 130g of seeds. The seed pulp of a ripe momordica cochinchinensis fruit is bright red in color and has a palatable bland to nutty taste.

It is very important therefore, to preserve or enhance these constituents in processed Gac fruit products, particularly the high levels of carotenoids and the associated antioxidant activity. Many studies have reported about Gac:

- Hiromitsu Aoki et al. (2002) determined carotene in Gac and concluded lycopene in Gac seed membrane with carotenoid concentrations to 380µg/g, 10 fold higher than those in any of the plant sources [4]
- L.T.Vuong et al. (2005) determined the acceptance of Gac supllementation to Vietnamese children. Results showed that vitamin A in Vietnamese children body was higher in Gac consumption than using β-carotene synthetic. They Vuong also reevaluated β-carotene content in fresh Gac fruit 408µg/g [3].
- Tran Hoang Thao et al. (2007) produced Gac powder by different drying methods. They proved that freeze drying method retained the highest β-carotene content. They also researched pretreatment methods to detach Gac seed membrane more easily, including thermal and enzyme. Loss of carotene by these pretreatment methods was 35%. If these products kept in vacuum below 25^0C would maintain red color and carotene to 70% in 4 month [5].

MATERIAL AND METHODS

Raw Gac fruit source

Gac fruits *(Momordica cochinchinensis* Spreng*)* are originally collected from Trang Bang, Tay Ninh province, Vietnam when they are in half ripen stage. They are kept 6 days and then experimented.

Figure 1: Half ripen Gac

Figure 2: Overal ripen Gac after 6 days

Raw material preparation

Gac fruits are choped into two parts, collect seed membrane, discard seed. In our experiments, we only use seed membranes without seed, pulp and skin.

Effect of temperature and time in blanching to carotenoid content

Experimental parameter:

- Temperature, time of blanching: 70^0C, 80^0C, 90^0C in 2 minutes, 4 minutes, 6 minutes.
- Control sample: Gac seed membrane without treatment.

Fixed parameter:

- Gac seed membrane after being blanched will be preserved in refrigerator at 5^0C, in 15 minutes.
- Weight of sample: 35g fresh Gac seed membrane
- Scatter sample in drying: 0,2g/cm^2.
- Temperature of drying: 60^oC.
- Moisture content of sample after being dryed: 6 ± 1%

Target parameter:

-Total carotenoid µg/g Gac seed membrane (dry matter).

Effect of citric concentration in blaching solution to carotenoid content

Experimental parameter:

- Acid citric concentration in blanching solution: 0,02%, 0,04%, 0,06%, 0,08%.
- Control sample: Gac seed membrane will be blanched at the approriate temperature and time derived from the previous experiment.

Fixed parameter:

- Temperature and time of blanching are selected from the previous experiment.
- Gac seed membrane after being blanched will be preserved in refrigerator at 5^0C, in 15 minutes.
- Weight of sample: 35g fresh Gac seed membrane.
- Scatter sample in drying: 0,2g/cm^2.
- Temperature of drying: 60^oC.
- Moisture content of sample after being dryed: 6 ± 1%

Target parameter:

-Total carotenoid µg/g Gac seed membrane (dry matter).

Effect of time in steaming to carotenoid content

Experimental parameter:

- Time of steaming: 2 minutes, 4 minutes, 6 minutes.
- Control sample: Gac seed membrane without treatment.

Fixed parameter:

- Temperature of steaming: 100^0C.
- Thickness of sample: 5-7mm.
- Temperature of Gac sample in steaming: 95-97^0C.
- Gac seed membrane after being steamed will be preserved in refrigerator at 5^0C, in 15 minutes.

- Weight of sample: 35g fresh Gac seed membrane
- Scatter sample in drying: 0,2g/cm^2.
- Temperature of drying: 60^{o}C.
- Moisture content of sample after being dryed: 6 ± 1%

Target parameter:

-Total carotenoid µg/g Gac seed membrane (dry matter).

Comparrion of pretreatment methods

Experimental parameter:

- Compare the different value between blanching in acid citric solution and steaming.
- Control sample: Gac seed membrane without treatment.

Fixed parameter:

- Temperature of steaming: 100^{0}C.
- Thickness of sample: 5-7 mm.
- Temperature of Gac sample in steaming: 95-97^{0}C.
- Gac seed membrane after pretreatments will be preserved in refrigerator at 5^{0}C, in 15 minutes.
- Weight of sample: 35g fresh Gac seed membrane
- Scatter sample in drying: 0,2g/cm^2.
- Temperature of drying: 60^{o}C.
- Moisture content of sample after being dryed: 6 ± 1%

Target parameter:

-Total carotenoid µg/g Gac seed membrane (dry matter).

RESULTS AND DISCUSSION

Effect of temperature and time in blanching to carotenoid content

Purpose of blanching is to inactivate enzyme in raw material. Gac is similar to other fruits having enzyme lipoxygenase, polyphenoloxidase, polygalacturonase. The present of these enzymes will create unbenefit change to product quality in upcoming steps [1]. Enzyme oxidase in drying process with appropriate temperature will deduct total carotene in finish product. Moreover, high temperature in blanching will significantly eliminate unfavorable performance by microorganisms in next drying.

Table 1: Effect of temperature and time in blanching to carotenoid content

Method	Replication	Average of carotene (µg/g seed membrane) (dry matter)	Difference to control (%)
Control	3	3254.10^a	0.00
70^{0}C	9	3410.40^b	4.80
80^{0}C	9	3594.42^c	10.46
90^{0}C	9	3182.26^a	2.21

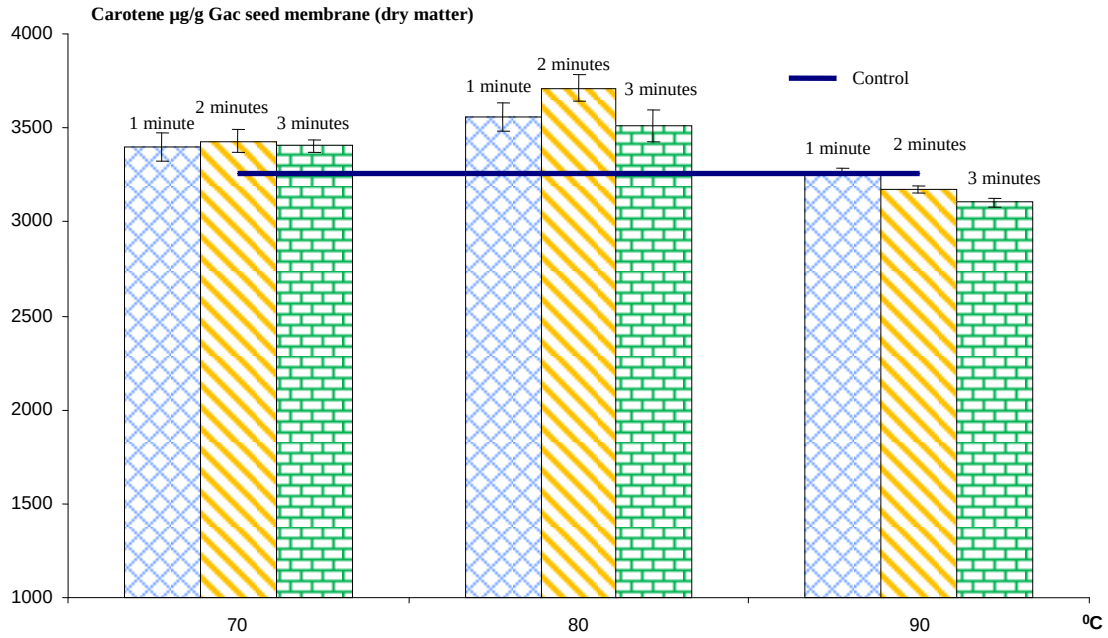

Figure 3: Effect of temperature and time in blanching to carotenoid content (µg carotene/g Gac membrane) (dry matter)

Statistical analysis Anova expresses that there is no significant difference in blanching temperature parameters as well as blanching durations. However, temperature and time have interract relation. Blanching in 70^0C and 80^0C will get more carotene then doing 90^0C. This phenophenon can be explained when blanching in high temperature (90^0C), internal substances will emit to surface and lose carotene or decompose carotene so its content in product will be less, protein be denatured, xtraction recovery be low. Blanching in 70^0C gets lower carotene than in 80^0C because this temperature is not effectively enough to inactivate enzyme. Results prove that blanching in 80^0C, 2 minutes is conformable for further experiments.

Effect of citric concentration in blaching solution to carotenoid content

We can see clearly that blanching has affected to total carotene in Gac powder. Acid citric supplementation into blanching solution will constrain oxidation, change pH of blanching solution, and inactivate enzyme and microorganism on surface. Result shows that blanching in acid citric solution will receive more carotene than control (blanching 80^0C, 2 minutes, without acid citric addition) owing to anti-oxidation of acid citric. With acid citric 0.04% in blanching solution, carotene content is thoroughly protected. Unfortunately with acid citric 0.06% carotene content after drying will be gradually reduced. This can be explained that acid citric 0.06% at 80^0C, protein encrusted on cell membrane is denatured, cell membrane is broken and carotene is released out, oxidized easily during drying. So acid citric solution 0.06% will made pH acid inapproriated; carotene molecule will be undurable on account of broken and oxidized molecule. So we select blanching Gac seed membrane in 80^0C, 2 minutes in 0.04% acid citric solution as optimum blanching condition.

Table 2: Effect of acid citric concentration during blanching (80^0C, 2 minutes) to total carotene in Gac powder

Method	Replication	Average of carotene (µg/g seed membrane) (dry matter)	Difference to control (%)
0 % citric (Control)	3	3356.92^a	0.00
0.02% citric	3	3538.97^b	5.42

0.04% citric	3	3645.11[c]	8.59
0.06% citric	3	3462.64[b]	3.15

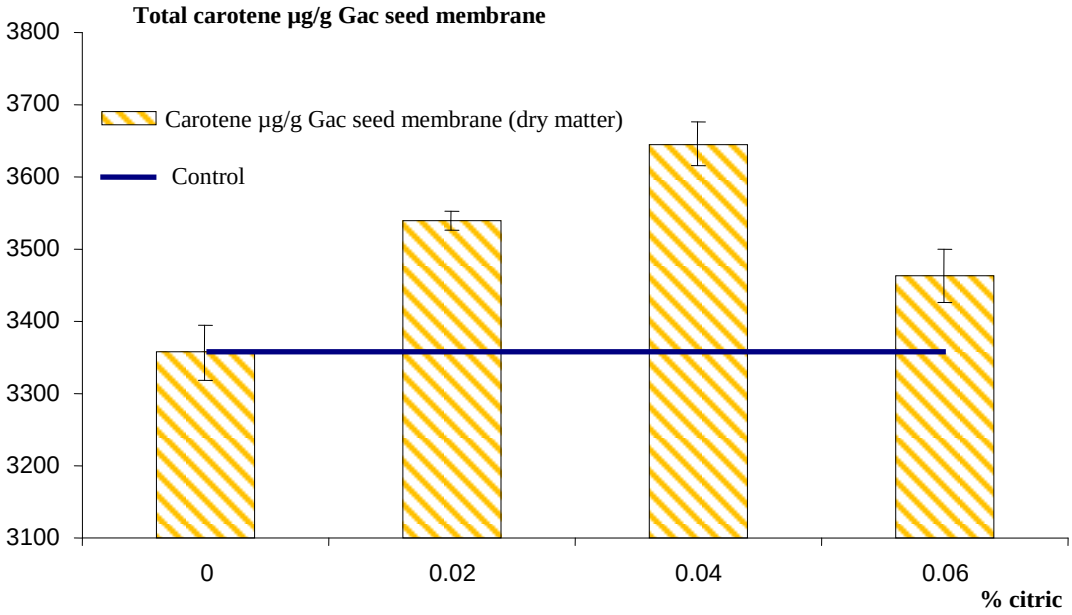

Figure 4: Effect of acid citric concentration during blanching (80^0C, 2 minutes) to total carotene in Gac powder (µg carotene/g Gac seed membrane) (dry matter)

Effect of time in blanching to carotenoid content

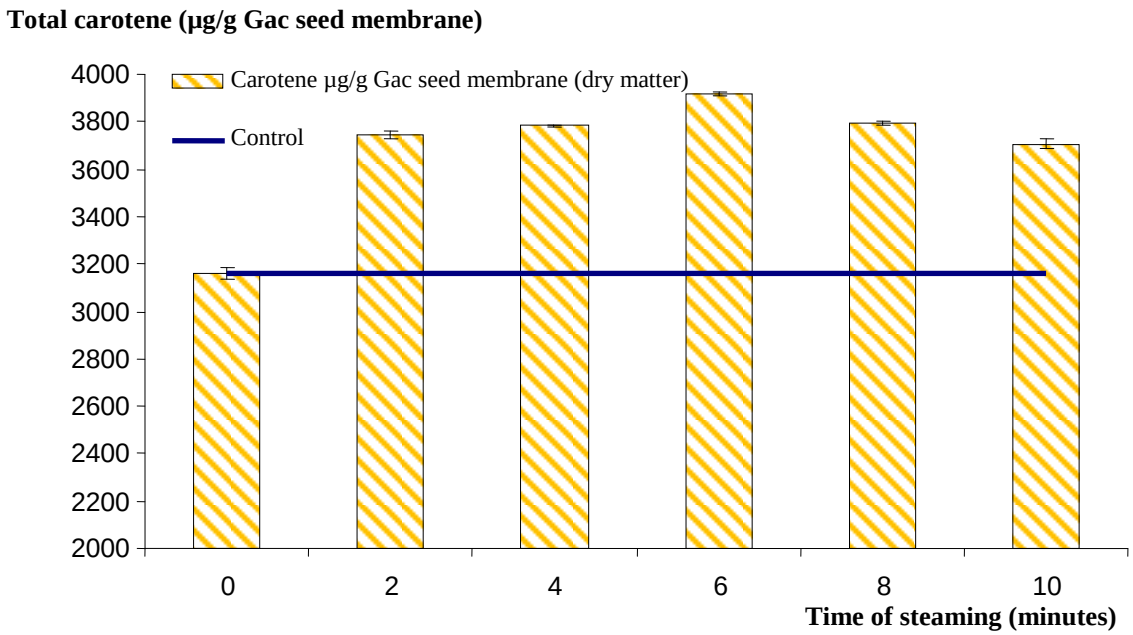

Figure 5: Effect of steaming time to total carotene in Gac powder (µg carotene/g Gac seed membrane) (dry matter)

Table 3: Effect of steaming time to total carotene in Gac powder

Method	Replication	Average of carotene (µg/g seed membrane) (dry matter)	Difference to control (%)
0 (Control)	3	3160.12[a]	0.00
2	3	3744.75[bc]	18.50
4	3	3782.98[c]	19.71
6	3	3917.38[d]	23.96
8	3	3792.87[c]	20.02
10	3	3705.33[b]	17.25

Purpose of steaming is similar to blanching, that means using high temperature to inactivate enzyme in raw material. Factors affected to raw material quality during steaming are volume of steam and duration of steaming. In this scope, despite we can't accurately estimate volume of steam, we can control water volume, cooker volume and temperature so we can consider volume of steam emits in this experiment as constant. In this experiment, we compare carotene content in Gac powder in various durations of steaming. Result and statistical analysis show that steaming in 6 minutes can maintain the highest content of total carotene in Gac powder so this value is chosen for further experiments.

Comparison of pretreatment methods

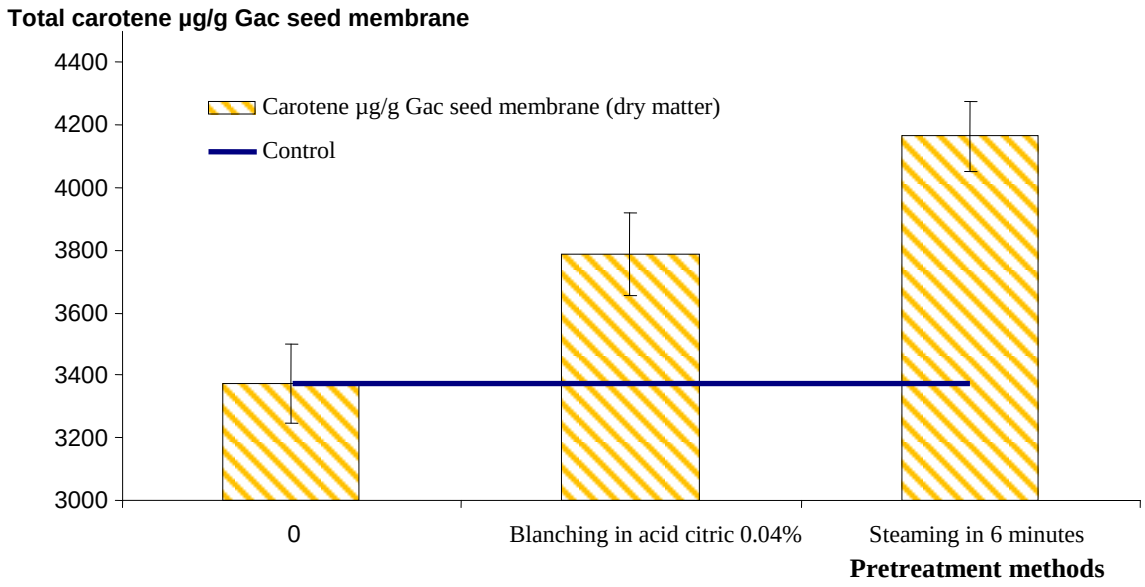

Figure 6: Effect of pretreatment methods to total carotene in Gac powder (µg carotene/g Gac seed membrane) (dry matter)

Table 4: Effect of pretreatment methods to total carotene in Gac powder

Method	Replication	Average of carotene (µg/g seed membrane) (dry matter)	Difference to control (%)
Control	3	3372.37[a]	0.00
Blanching in citric 0.4%	3	3787.60[ab]	12.38

Steaming in 6 minutes	3	4165.44[b]	23.59

Result of this experiment proves that steaming in 6 minutes can keep the highest total carotene in Gac seed membrane, 10% higher than blanching in acid citric 0.04%. This result can be explained that steaming will inactivate enzyme and microorganism in raw material without leaking carotene to outside cell membrane, strongly support to the complete carotene extraction. So steaming in 6 minutes is selected as pretreatment method before mixing the carrier. This process will enhance total carotene in Gac seed membrane to 23.59% compared to control (no treatment).

Evaluation of carotene fluctuation in experiments

On above experiments, we summarize and evaluate the variation of carotene content in each pretreatment method comparing to carotene content in non-treatment.

Nguyen Minh Thuy et al. [2], evaluated Gac sample dried at 45 – 65^{0}C in various durations 10 - 60 minutes. They showed that carotenoid content in fresh raw Gac 2630 – 4500 µg/g, this result was kết similar to other studies (Isida et al. 2004; Tran et al. 2007) but higher than some studies (Aoki et al. 2002; Vuong et al. 2005). This difference was probably Gac sources; ripen status, climate, post-harvest, analysis method etc [2]. In our research, we only analyze total carotene in Gac seed membrane treated by different methods to find out the optimum treatment to completely protect carotene in Gac fruit.

Nguyen Minh Thuy et al. (2009) [2] viewed total carotene varied after post harvest; total carotene after 6 day preservation was 2635.15 ± 385.50 (µg/g). This could be explained although Gac fruits were harvest in the same protocol (same place, half ripen, 6 days post-harvested), carotene varied in range ± 15% owing to characteristic of raw material. Therefore, total carotene in samples treated by different methods could show carotene variation in range ± 15%.

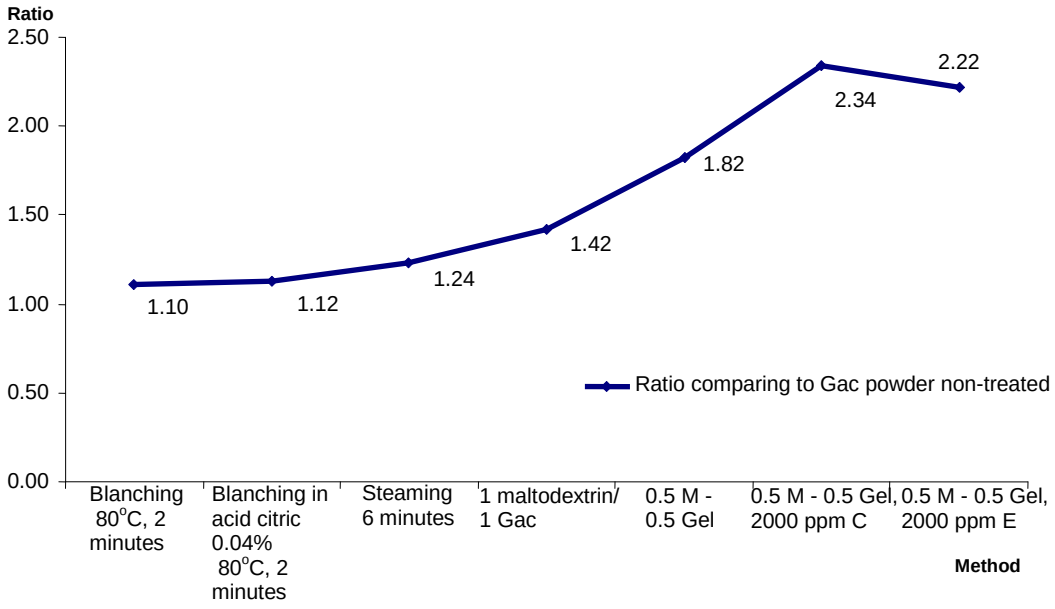

Figure 7: Ratio of carotene in various pretreatment methods compared to carotene of Gac seed membrane non-treated

CONCLUSION

Pretreatment methods such as blanching 80^{0}C, 2 minutes; blanching in acid citric solution 0.04% in 80^{0}C, 2 minutes or steaming in 6 minutes can effectively preserved carotene, loss reduction during drying Gac powder

in 60^0C. Among them, steaming in 6 minutes can is the most suitable selection to maintain carotene content in Gac seed membrane in the pretreatment process.

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