Investigation Different Pretreatment Methods And Ratio Of Carrier Materials To Maintain Carotenoids In Gac (*Momordica Cochinchinensis* Spreng) Powder In Drying Process

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

Abstract: Availability of gac fruit is seasonal, three months out of the year, harvesting start on September and lasts until December. In Vietnam, gac vines are grown mainly in the red river delta areas.. 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 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; as well as to investigate the different ratioes of carrier material to find out which one is the adequate ratio to protect carotene in Gac powder. 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; and the most appropriate ratio of carrier: Gac is 1: 1 (dry matter) in which the ratio of maltodextrin: gelatin is 0.5: 0.5 (w/w)..

Key words: Gac fruit, blanching, steaming, carrier material, maltodextrin, gelatin, carotenoids

1. 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.

Table 1. Scientific classification of Gac

Kingdom:	Plantae		
Division:	Magnoliophyta		
Class:	Magnoliopsida		
Order:	Cucurbitales		
Family:	Cucurbitaceae		
Subfamily:	Cucurbitoideae		
Tribe:	Joliffieae		
Subtribe:	Thladianthinae		
Genus:	*Momordica* L.		

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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. ß-carotene is an antioxidant containing highly in Gac fruit, a common fruit grown on Vietnam rural area. Therefore, researches to manufacture Gac powder with the purpose of preserving and protecting ß-carotene to optimum level will be very essential not only to create food source having high content of antioxidant, very helpful to human health but also to utilize cheap and available raw material in domestic. Many studies proved that Gac highly contains ß-carotene and lycopene; total carotenoid varies in range 3768.3 – 7516µg/g [10], ß-carotene (17-35mg/100g edible portion) [13]. Gac fruits also have a large amount of α-tocopherol (Vitamin E) [13] and fatty acid [12]. ß-carotene, lycopene and vitamin E are all antioxidant, role as improving human immune and resisting to cancer and aging. Many researchers also emphasized Gac as a clean safe fruit, more effectively than tomato and carrot regarding antioxidase owing to its edible portion having ß-carotene two folds compared to liver oil of tuna fish and 10 folds to carrot. Entering human body, ß-carotene will be bio-transformed to vitamin A under attack of carotenase depending on vitamin A demand inside human body. Consumption of Gac powder will not be considered vitamin A overload.

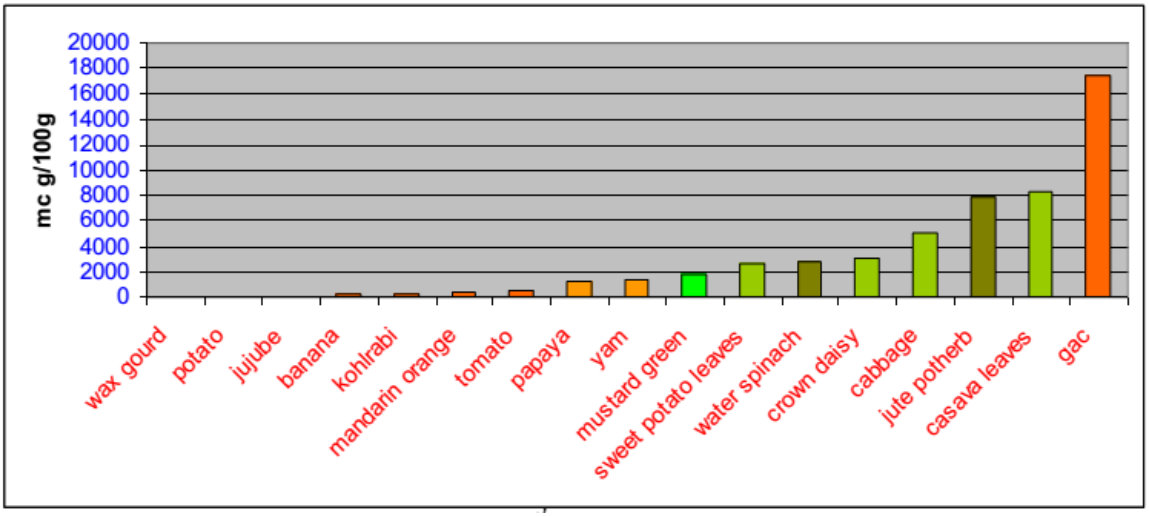

Figure 1. Beta-carotene contents of "Gac" fruits and other commonly consumed fruits and vegetables in northern Vietnam [12]

In composition of Gac, seed membrane contains the highest density of lycopene and ß-carotene. Lycopene in seed membrane accounts for 380µg/g, 10 folds higher than other fruits [8, 12]. In fresh Gac fruit, lycopene covers 2227µg/g. Seed membrane also keeps a large amount of fatty acids to 17%-22% weight [14]. Oil extracted from Gac has total carotenoid 5700µg/ml, where ß-carotene accounts for 2710µg. Gac oil also includes vitamin E excessively [14]. Gac skin has aburnable lutein. Phenol substances in Gac include gallic acid and p-hydroxybenzoic acid; seed membrane also contains acid ferulic [12, 14]

Table 2. Approximate nutrient composition of Momordica cochinchinensis spreng (per 100g of edible portion) [12]

	Water	Calories	CHO	Protein	Fat	Fiber	Ash	ß-car	Ca	P
	%	Kcal	g	G	G	g	Mg	µg	mg	mg
Fruit	90,2	29	6,4	0,6	0,1	1,6			27	38
Seed pulp	77	125	10,5	2,1	7,9	1,8	0,7	45780	56	6,4

Table 3. Fatty acid composition of Gac pulp [12]

Name	mg/100g edible portion	% total fattyacids
Myristic	89	0,87
Palmitic	2248	22,04
Palmitoleic	27	0,26
Stearic	720	7,06
Oleic	3476	34,08
Vaccenic	115	1,13
Linoleic	3206	31,43
alpha linolenic	218	2,14
Eicosanoic	40	0,39
Gadoleic	15	0,15
Arachidonic	10	0,10
Docosanoic	19	0,19
Tetracosanoic	14	0,14
Total	**10.198**	**mg/ 100g edible portion**

In ripe Gac fruit, β-carotene is the dominant carotenoid. In addition to carotene, Gac pulp also contains a significant amount of oil. Fatty acid analyses indicate that Gac contains 852 mg per 100gof edible portion. Seventy percent of the total fatty acids of Gac pulp comprise of unsaturated fatty acid, 50% of which are polyunsaturated. Approximate nutrient composition of Gac fruit is provided. Fatty acid composition of Gac pulp is listed in table 2 [12]. It is very important therefore, to preserve or enhance these constituents in processed Gac 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 [8]
- 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 [5].
- 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^{0}C would maintain red color and carotene to 70% in 4 month [10].
- Nguyen Minh Thuy et al. (2009) manufactured variety of Gac products such as: dried Gac seed membrane, jelly, gum, paste, oil and juice. They also proved the change of carotene in Gac seed membrane after 6 days harvested [2]
- Dang Thi Tuyet Nhung et al. (2009) evaluated the change of lycopene and β-carotene in Gac seed membrane and Gac oil during preservation. Gac seed membrane primarily contained lycopene 2.378 – 3.728mg/g (raw material), β-carotene 0.257 – 0.379mg/g (raw material), carotene stabilized within the first one week by strongly decomposed in the second week of preservation. Gac oil extracted from seed membrane with addition of 0.02% BHT, it could be preserved 15 to 19 weeks at 5^{0}C, 40^{0}C, 60^{0}C; lycopene and β-carotene also reduced dramatically [4].
- Tuyen Chan Kha et al. (2010) produced Gac powder by using spray drying method with maltodextrin supplementation. They concluded that the appropriate drying process to keep red color was in temperature 120^{0}C, 10% maltodextrin as carrier material (w/v) [11].

In this paper, we examine various pretreatment methods and the carrier materials to cover and limit oxidation of carotene during drying step.

2. MATERIAL AND METHODS

2.1 Raw material Gac (*Momordica cochinchinensis* Spreng) 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.

2.2 Carrier material

Maltodextrin

Maltodextrin is originally provied from Germany. Using maltodextrin having high DE will increase moisture and energy iin drying as well as bad encapsulation appearance. In this study we choose maltodextrin having DE = 10.

Gelatin

Gelatin 125 blum is supported from Nitta (Canada) 100% purity, extracted from pig skin.

2.3 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.

2.4 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).

2.5 Effect of citric concentration in blaching solution to carotenoid content

Experimental parameters:

- 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).

2.6 Effect of time in steaming to carotenoid content

Experimental parameters:

- Times 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^{0}C.
- 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: 60^0C.
- Moisture content of sample after being dryed: 6 ± 1%

Target parameter:

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

2.7 Comparison of pretreatment methods

Experimental parameters:

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

Fixed parameter:

- Temperature of steaming: 100^0C.
- 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 5^0C, in 15 minutes.
- Weight of sample: 35g fresh Gac seed membrane
- Scatter sample in drying: 0,2g/cm^2.
- Temperature of drying: 60^0C.
- Moisture content of sample after being dryed: 6 ± 1%

Target parameter:

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

2.8 Mixing Gac seed membrane with carrier materials

Mixing with maltodextrin

Experimental parameters:

- Ratio of maltodextrin/ Gac dry matter: 0/1; 0.5/1; 1/1; 1.5/1; 2/1 (w/w).
- Control sample: Gac seed membrane collected from steaming 6 minutes and grinding (without carrier)

Fixed parameter:

- Maltodextrin solution 50% weighed and supplemented into raw material powder in equivalent ratio.
- Gac seed membrane after being pretreated in preserved in refrigerator 5^0C, 15 minutes.
- Sample weigth: 35g raw 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).

Mixing Gac seed membrane with maltodextrin - gelatin

Experimental parameters:
- Ratio of maltodextrin-gelatin: based on result of the last experiment, varied gelatin concentration 10%, 20%, 30%, 40%, 50% to volume of maltextrin, and reduce volume of maltodextrin in equivalent to gelatin suplemented (dry matter).
- Control sample: Gac seed membrane treated with method from the last experiment.

Fixed parameter:
- Solution 50% carrier (maltodextrin- gelatin) is weighed and added into raw material in equivalent ratio.
- Gac seed membrane after being pretreated in preserved in refrigerator 5^{0}C, 15 minutes.
- Sample weigth: 35g raw 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).

3. RESULTS AND DISCUSSION

3.1 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. 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^{0}C and 80^{0}C will get more carotene then doing 90^{0}C. This phenophenon can be explained when blanching in high temperature (90^{0}C), 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^{0}C gets lower carotene than in 80^{0}C because this temperature is not effectively enough to inactivate enzyme. Results prove that blanching in 80^{0}C, 2 minutes is conformable for further experiments.

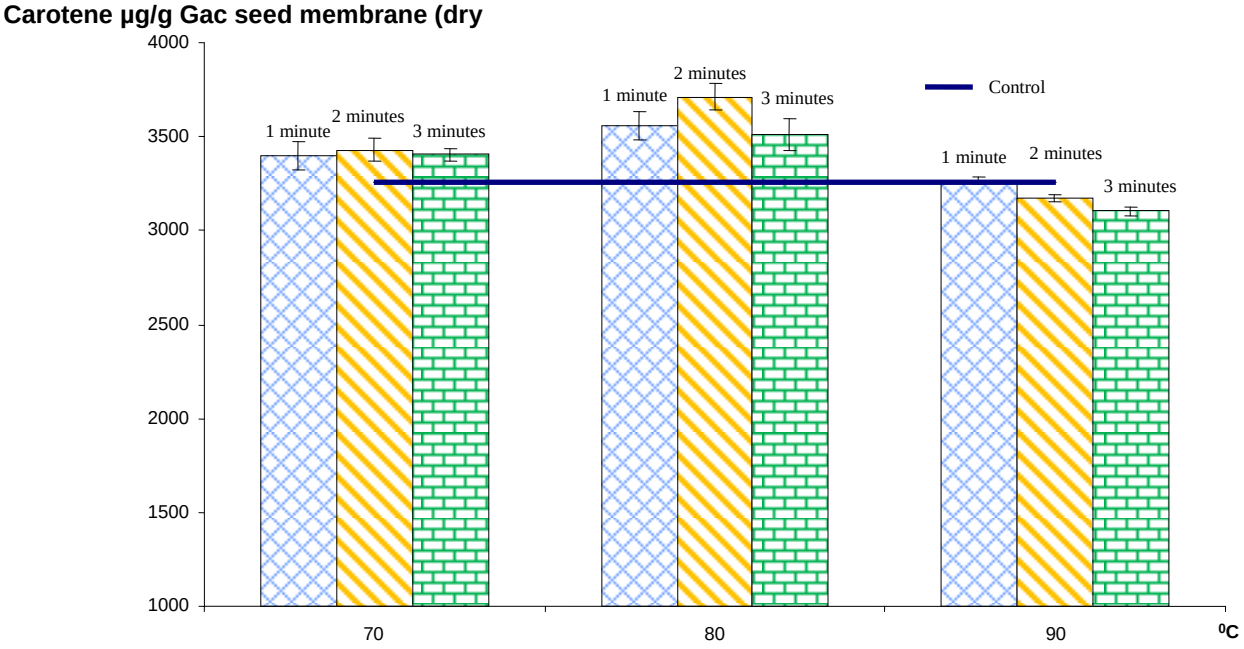

Figure 2. Effect of temperature and time in blanching to carotenoid content (µg carotene/g Gac membrane) (dry matter)

Table 4. 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
70^0C	9	3410.40[b]	4.80
80^0C	9	3594.42[c]	10.46
90^0C	9	3182.26[a]	2.21

3.2 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.

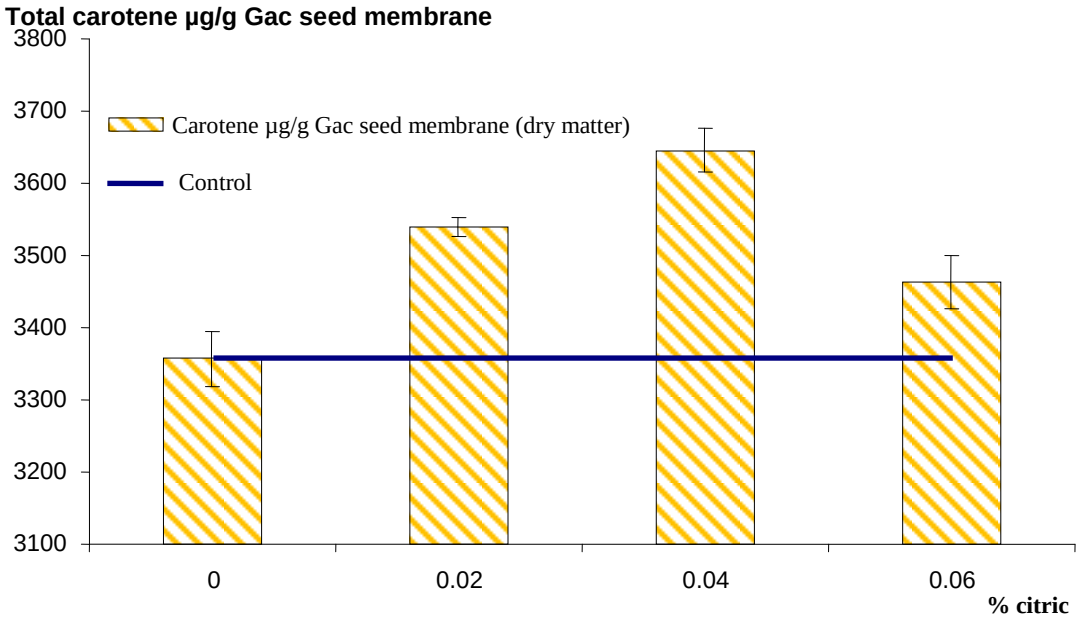

Figure 3. Effect of acid citric concentration during blanching (80^0C, 2 minutes) to total carotene in Gac powder (µg carotene/g Gac seed membrane) (dry matter)

Table 5. 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

3.3 Effect of time in blanching to carotenoid content

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.

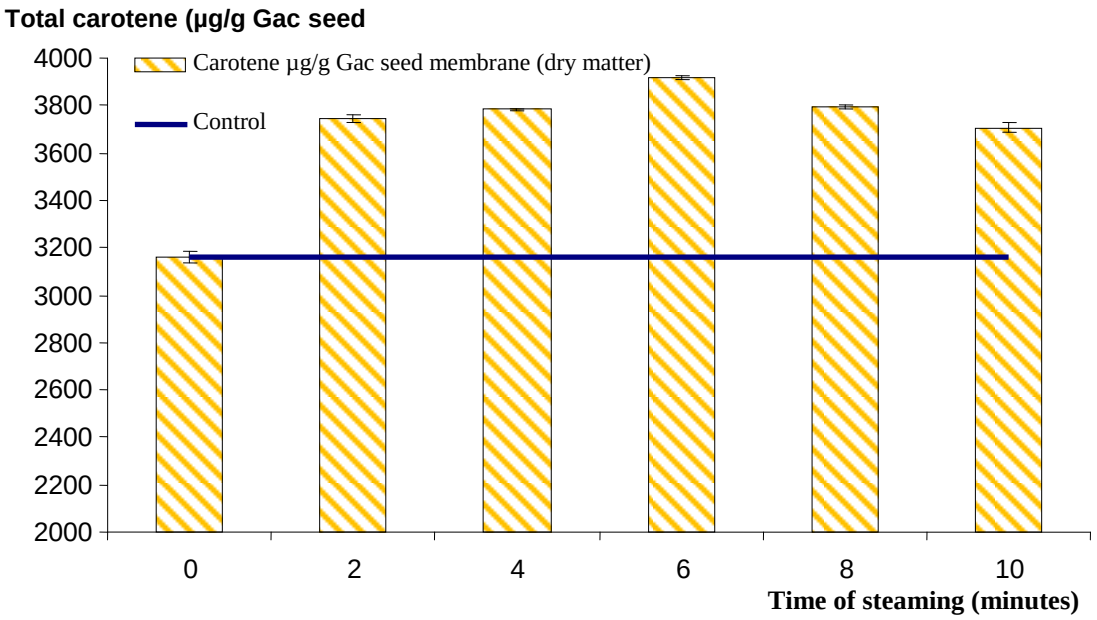

Figure 4. Effect of steaming time to total carotene in Gac powder (µg carotene/g Gac seed membrane) (dry matter)

Table 6. 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

3.4 Comparison of pretreatment methods

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).

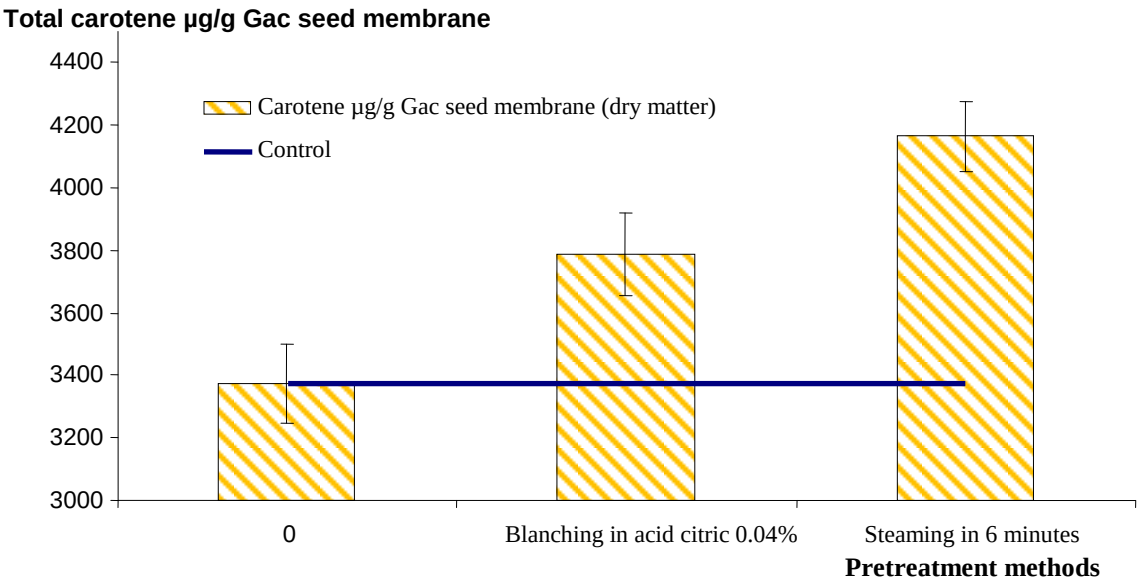

Figure 5. Effect of pretreatment methods to total carotene in Gac powder (µg carotene/g Gac seed membrane) (dry matter)

Table 7. 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

3.5 Evaluation of carotene fluctuation in experiments

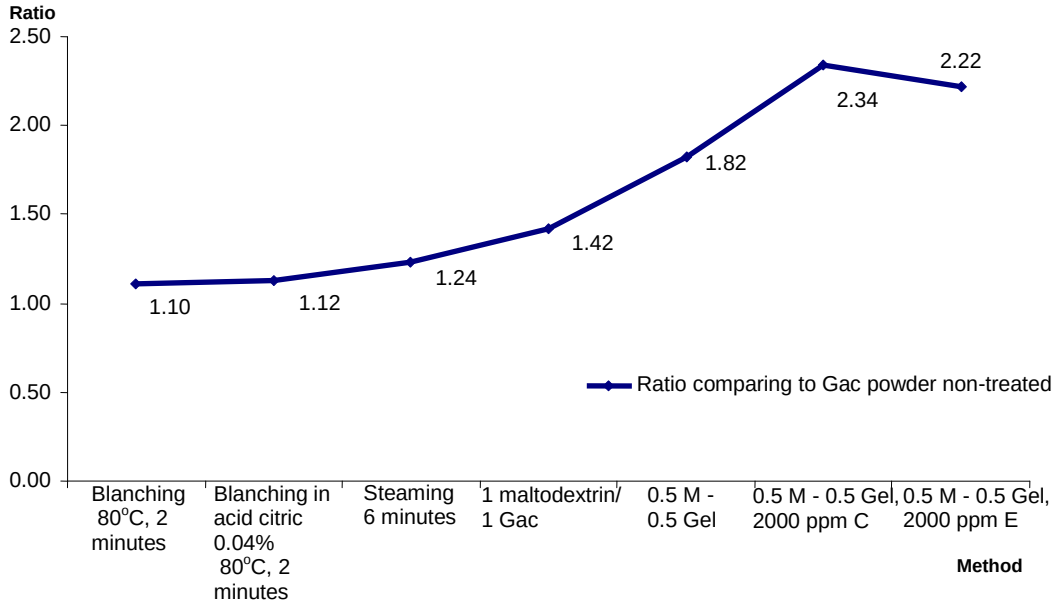

Figure 6. Ratio of carotene in various pretreatment methods compared to carotene of Gac seed membrane non-treated

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 [3]. 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) [3] 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%.

3.6 Effect of maltodextrin concentration

Our results show that maltodextrin addition will limit carotene loss comparing to control sample (only steaming). Maltodextrin added into raw material after being steamed 6 minutes, cooled, grinded will act as protect agent for carotene in front of oxygen during drying step. Anova stastical analysis (α = 0.05) clearly expressed the difference of ratio 0.5:1; 1:1; 1.5:1; 2:1; (maltodextrin: Gac seed membrane). Comparing to control sample, total carotene of sample with ratio 1:1 is higher 34.94%. So we choose maltodextrin: Gac seed membrane with ratio 1:1 (dry matter) for further experiments.

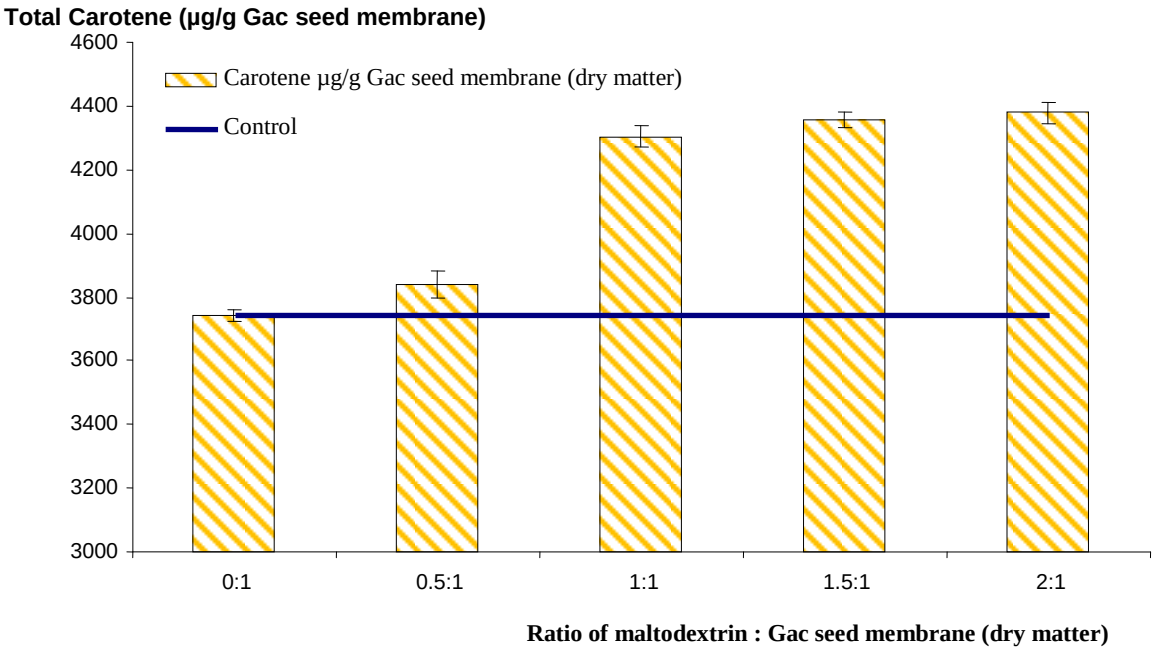

Figure 7. Effect of maltodextrin addition to total carotene in Gac powder (µg carotene/g Gac seed membrane) (dry matter)

Table 8. Effect of maltodextrin addition to total carotene in Gac powder

Ratio Maltodextrin: Gac (dry matter)	Replication	Average of carotene (µg/g seed membrane) (dry matter)	Difference to control (%)
0:1 (Control)	3	3740.97[a]	0
0.5:1	3	3839.87[a]	20.43
1:1	3	4302.76[b]	34.94
1.5:1	3	4356.76[b]	36.64
2:1	3	4378.25[b]	37.31

Figure 8. Comparison of Gac powder with different ratio with maltodextrin

3.7 Effect of ratio maltodextrin-gelatin

In this experiment, we accumulate gelatin amount, deduct maltodextrin amount. Ratio of carrier: Gac seed membrane (dry matter) is still fixed at 1:1. Result shows that gelatin addition to maltodextrin will prevent total carotene loss through increasing gelatin equivalent to maltodextrin. Statistical analysis (α=0.05) shows the highest carotene while mixing maltodextrin: gelatin at ratio 0.5: 0.5. Gelatin acts as surface reagent, dissolve in water more easily at high temperature over thawing point, with hydrophobic series in molecule. When mixing sution of gelatin and maltodextrin into raw Gac seed membrane steamed, grinded; gelatin will dissolve with lipid in Gac so it covers carotene more effectively. Gelatin in outer together with maltodextrin will isolate oxygen penetrate into Gac powder. While moisture vapors in drying step, gelatin forms firm gel layer to cover Gac powder.

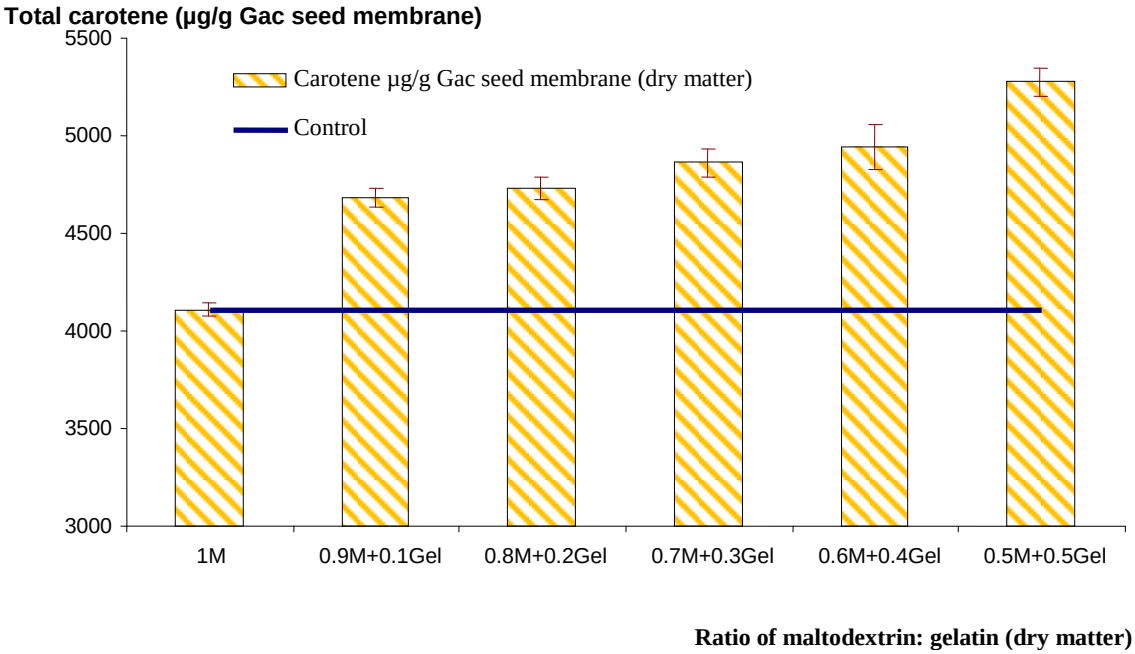

Figure 9. Effect of maltodextrin – gelatin ratio to total carotene in Gac powder (µg carotene/g Gac seed membrane) (dry matter)

Table 9. Effect of maltodextrin – gelatin ratio to total carotene in Gac powder

Method	Replication	Average of carotene (µg/g seed membrane) (dry matter)	Difference to control (%)
1M (Control)	3	4109.30[a]	0.0
0.9M+0.1Gel	3	4681.65[b]	13.9
0.8M+0.2Gel	3	4728.61[bc]	15.1
0.7M+0.3Gel	3	4860.68[bc]	18.3
0.6M+0.4Gel	3	4939.95[c]	20.2
0.5M+0.5Gel	3	5277.30[d]	28.4

Figure 10. Gac powder with different ratio of carrier maltodextrin-gelatin

Our experiment demonstrates gelatin supplementation at concentration 50% to maltodextrin to prevent carotene loss in Gac seed membrane, which is expressed in carotene higher 28.4% compared to control sample, only using carrier maltodextrin with ratio maltodextrin: Gac seed membrane 1:1 (dry matter). However in our scope, we only choose maltodextrin the main carrier, gelatin as the supplementing agent to protect carotene; and ratio 50% of maltodextrin: gelatin. If we increase gelatin and decrease maltodextrin, viscosity will be too concentrated and form unexpected gel. From 1 kg raw Gac fruit, we get 200g seed membrane (20%), remove 80g seed (8%). Moisture of seed membrane is about 80% so 200g seed membrane is equal to 40g dry matter. In general, raw Gac fruit contains about 4% dry matter of seed membrane. On our calculation for above experiments, we decide the pretreatment method by steaming in 6 minutes, carrier ratio 1:1, maltodextrin: gelatin 0.5: 0.5 (dry matter). Total carotene in Gac powder (dry matter) is about 6000µg/g seed membrane; β-carotene is about 500µg/g seed membrane.

4. 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^{0}C. Among them, steaming in 6 minutes can is the most suitable selection to maintain carotene content in Gac seed membrane in the pretreatment process. Using maltodextrin and gelatin as carrier has advantage of carotene loss prevention during drying Gac powder. Ratio of carrier is suitable at 1: 1 (carrier: Gac seed membrane), ratio of mixing 0.5: 0.5 (maltodextrin: gelatin) (dry matter). We recommend further studies, including: variation of carotene in Gac fruit before and after harvest; other carrier to protect carotene as rice starch, gum Arabic; gelatin as the main carrier; inert air in drying Gac powder; other drying methods as freeze drying, spray drying with different carrier materials.

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