ISSN 2347- 6893

Investigation the different ratios of carrier material to protect carotenoids in Gac (Momordica cochinchinensis Spreng) powder in drying process

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ABSTRACT

Momordica cochinchinensis Spreng, Cucurbitaceae, is indigenous to Southeast Asia and consumed there for dietary as well as medicinal uses. In Viet Nam, this plant is called ''Gac'', and the seed membrane (seed pulp or aril) of the ripe fruit is widely used as a rice colorant due to its intense red color from its high carotene content. The aim of this study is to investigate the different ratios of carrier material to find out the appropriate ratio to protect carotene in Gac powder. The result shows that the most appropriate ratio of carier: Gac is 1: 1 (dry matter) in which the ratio of maltodextrin: gelatin is 0.5: 0.5 (w/w).

Key words: Momordica cochinchinensis Spreng, carrier material, carotenoids, maltodextrin, gelatin

Council for Innovative Research

Peer Review Research Publishing System

Journal: Journal of Advances in Biology

Vol. 1, No. 1

editor@cirworld.com

www.cirworld.com, member.cirworld.com

ISSN 2347- 6893

INTRODUCTION

Nutritional composition of momordica cochinchinensis (Gac) seed pulp

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 [8], ß-carotene (17-35mg/100g edible portion) [11]. Gac fruits also have a large amount of α-tocopherol (Vitamin E) [11] and fatty acid [10]. 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 pwder will not be considered vitamin A overload.

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 [6, 10]. In fresh Gac fruit, lycopene covers 2227µg/g. Seed membrane also keeps a large amount of fatty acids to 17%-22% weight [12]. Oil extracted from Gac has total carotenoid 5700µg/ml, where ß-carotene accounts for 2710µg. Gac oil also includes vitamin E excessively [12]. Gac skin has aburnable lutein. Phenol substances in Gac include gallic acid and p-hydroxybenzoic acid; seed membrane also contains acid ferulic [10, 12]

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 [10].

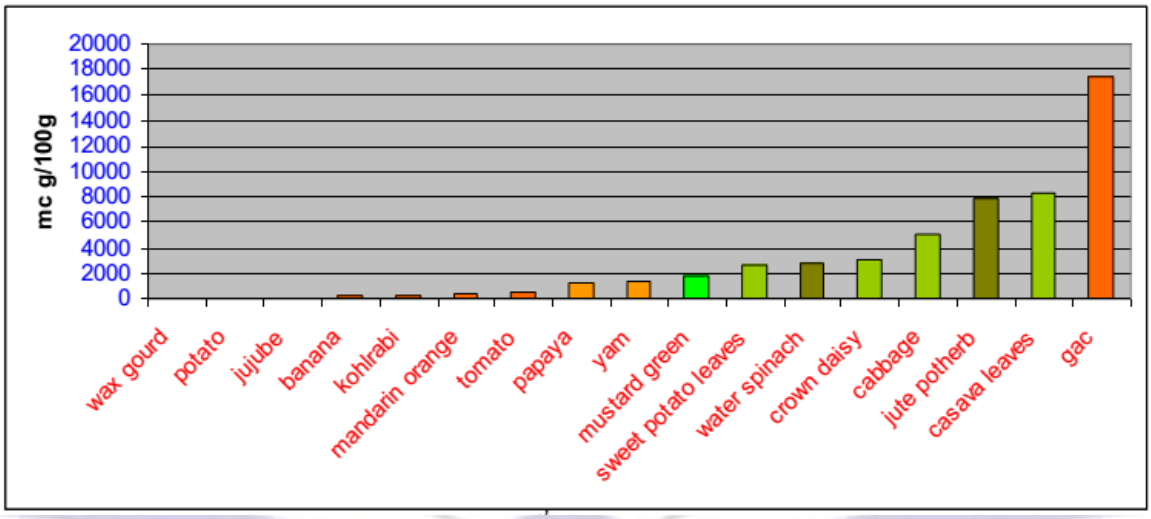


Figure 1. Beta-carotene contents of “Gac” fruits and other commonly consumed fruits and vegetables in northern Vietnam [10]

Table 1. Approximate nutrient composition of Momordica cochinchinensis spreng (per 100g of edible portion) [10]

	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

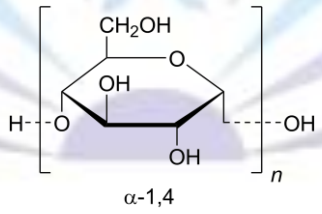
Table 2. Fatty acid composition of Gac pulp [10]

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

Carrier material

Maltodextrin

Maltodextrins are defined as non-sweet, nutritive saccharide polymers consisting of D-glucose units linked primarily by -1,4 bonds and having a maximum dextrose equivalent (DE) of less than 20. Following local developments the regulations restricted the preparation to partial hydrolysis of cornstarch by treatment with acids and enzymes resulting in a white powder or concentrated solution. Developed processes for production of maltodextrins are manifold and included finally also potato starchas substrate, in particular in the production of speciality maltodextrins [2, 5, 7]



α-1,4

$2 < n < 20$

Figure 2. Maltodextrin

Gelatin

Gelatine which is a water-soluble protein, has not only a good coating property for the encapsulation process but is also nontoxic, inexpensive and commercially available, in addition to being another effective wall material. Using a gelatine matrix is the best way to protect carotenoid pigments, especially trans-β-carotene [4, 5].

Many studies have reported about Gac

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 [1]

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 50C, 400C, 600C; lycopene and β-carotene also reduced dramatically [3].

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 1200C, 10% maltodextrin as carrier material (w/v) [9].

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

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 3. Half ripen Gac

Figure 4. Overal ripen Gac

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.

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.

Mixing Gac seed membrane with carrier material

Mixing with maltodextrin

Experimental parameter:

- 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^oC.
- 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 parameter:

- 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 5^0C, 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).

RESULTS AND DISCUSSION

Effect of maltodextrin concentration

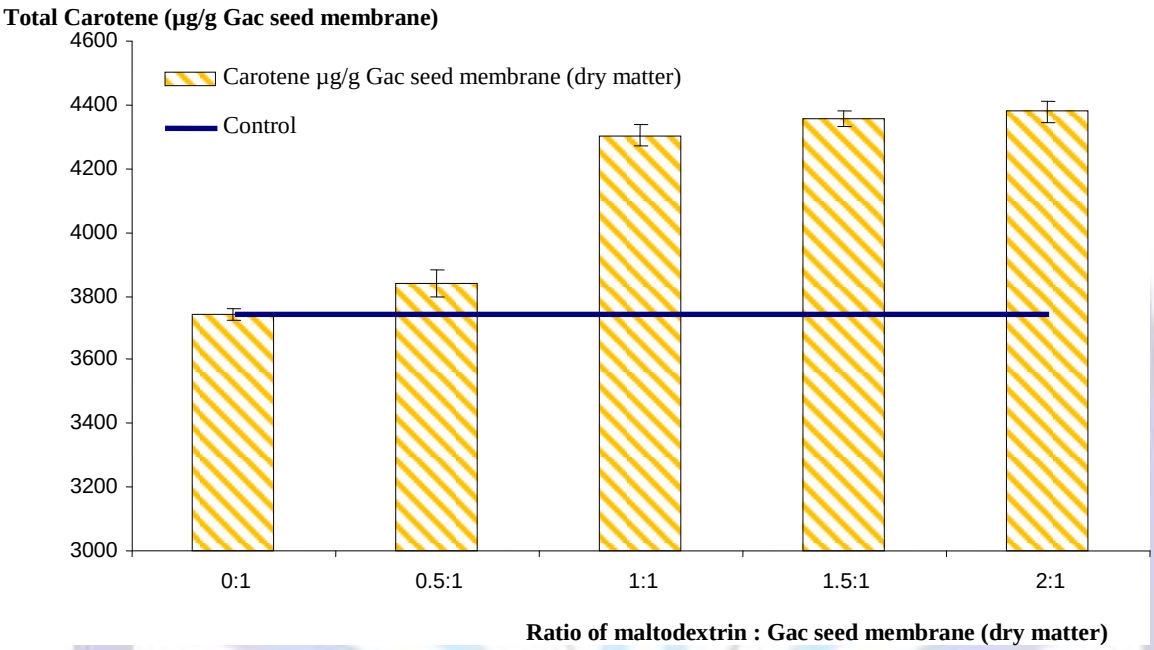


Figure 5. Effect of maltodextrin addition to total carotene in Gac powder (µg carotene/g Gac seed membrane) (dry matter)

Table 3. 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

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.

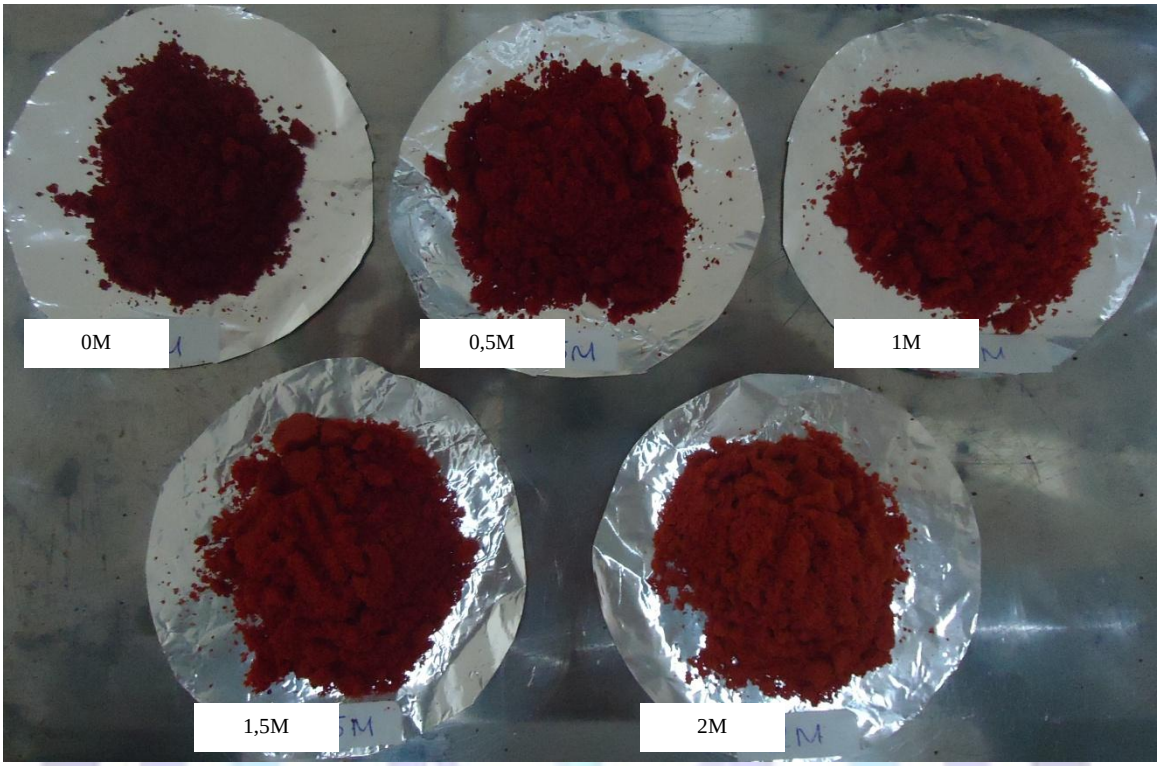


Figure 6. Comparison of Gac powder with different ratio with maltodextrin

Effect of ratio maltodextrin-gelatin

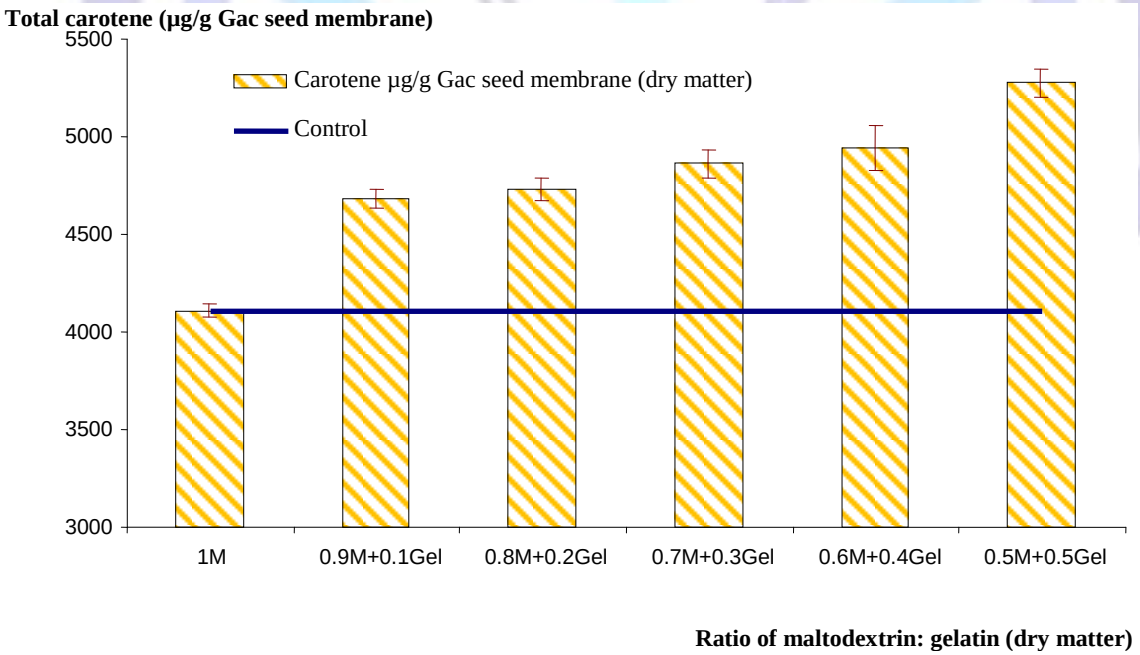


Figure 7. Effect of maltodextrin – gelatin ratio to total carotene in Gac powder (µg carotene/g Gac seed membrane) (dry matter)

Table 4: 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

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.

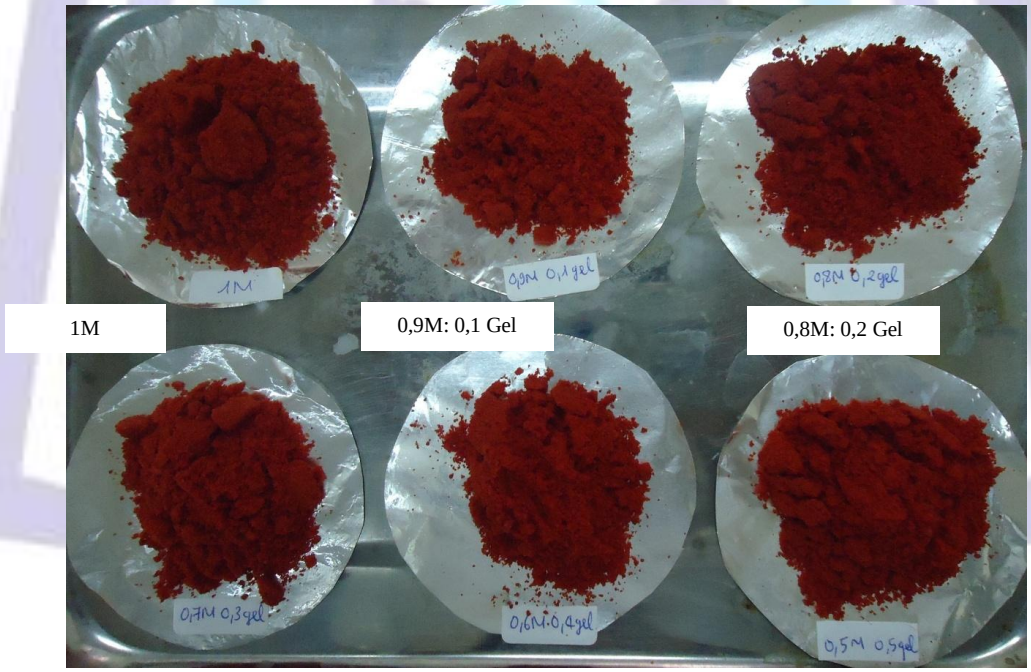


Figure 8. Gac powder with different ratio of carrier maltodextrin-gelatin

Our exp rates gelatin supple ncentration 50% to n revent 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.

CONCLUSION

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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