EFFECT OF DIFFERENT GUM TYPES ON STABILITY OF ANTIOXIDANT COMPONENTS AND PHYSICAL PROPERTIES OF SPRAY DRIED POUZOLZIA ZEYLANICA POWDER

Nguyen Duy Tan¹,*, Nguyen Minh Thuy²

¹Faculty of Agriculture and Natural Resources, An Giang University, 18 Ung Van Khiem Street, Dong Xuyen Ward, Long Xuyen City, An Giang Province
²School of Agriculture and Applied Biology, Can Tho University, Campus II, 3/2 Street, Xuan Khanh Ward, Ninh Kieu District, Can Tho City, Vietnam

*Email: ndtan@agu.edu.vn

Received: 28 August 2017, Accepted for Publication: 10 October 2017

ABSTRACT

The objective of this study was to investigate effect of blending three types of different gum (arabic, carrageenan and xanthan) in Pouzolzia zeylanica extract together with maltodextrin as well as encapsulated material during spray-drying process on the stability of antioxidant components (anthocyanin, flavonoid, polyphenol, tannin and antioxidant activities through DPPH radical scavenging capacity, ferrous reducing/antioxidant power FRAP and antioxidant ability index AAI); and physical properties (moisture content, water activity, particle size and morphology as well as the color, nonenzymatic browning) of products. The results showed that the sample which was blended with arabic gum and maltodextrin maintained well bioactive compounds and obtained powder had better quality characteristics than others. In this optimal sample, the content of anthocyanin, flavonoid, polyphenol and tannin were determined as 7.56 ± 0.106 mgCE/100 g, 31.15 ± 1.035 mgQE/g, 27.96 ± 0.380 mgGAE/g, 25.79 ± 0.530 mgTAE/g. The antioxidant activity through DPPH, FRAP and AAI were determined as 75.55 ± 0.65%, 102.87 ± 3.85 µM FeSO₄/g and 38.17 ± 11.24. The moisture content, water activity, particle size, the color value of (L, a, b), total color difference (ΔE) and non enzyme browning (NEB) were determined as 6.42 ± 0.085 %, 0.5142 ± 0.0076, 6.26 ± 0.110 µm, 78.43 ± 0.189, 7.55 ± 0.065, 6.96 ± 0.180, 18.85 ± 0.580 and 0.298 ± 0.015, respectively.

Keywords: antioxidant activity, color, different gum types, physical properties, spray dried Pouzolzia zeylanica powder.

1. INTRODUCTION

Pouzolzia zeylanica is one of the medicinal plants which people from many Asian countries have used to treat various kinds of diseases by traditional method such as poultice to bone fractures, boils, stomachache, diabetes, eyes injuries, itching, dysentery and loose stools of infant, prevention from radiation and confirmed therapeutic value of polyphenols contained in
the leaves. In Vietnam, this plant was popularly cultivated in the Mekong Delta region; it can be used as fresh or dried plant, decoction drink to treat cough with phlegm, pulmonary tuberculosis, sore throat, enteritis, diuretic, anti-inflammation, urinary infections, galactopoietics, and pulmonary disease. In the world of modern medicine, *Pouzolzia zeylanica* is also combined with other herbs to be able to fight against cancer cells, tuberculosis and to be good for your lungs.

With good medicinal characteristics of *Pouzolzia zeylanica*, instant tea was produced from extract actually necessary in order to advance usage value of this plant. In spray drying technology, there are various wall materials to be used to encapsulate the food ingredients and secondary metabolites such as starches, maltodextrin, gum arabic, guar gum, pectin, sodium alginate, sodium caseinate, carboxymethyl cellulose, soy and wheat protein, chitosan, gelatin [1]. These substances have important matrix forming properties like wall materials that they can protect susceptible ingredients during spray drying process. Maltodextrin is dry aid that is widely used in spray drying industry. Besides, gum is colloidal group that is also often used as carrier in spray drying medicinal plant extract. Many studies showed that using maltodextrin combined with various gum types will increase yield of drying process and have maintained high content of bioactive compounds. Hence, the study was carried out to evaluate the effect of arabic, carrageenan and xanthan gum combined with maltodextrin on stability of antioxidant components and physical properties of finished product.

2. MATERIALS AND METHODS

2.1. Materials

Chemicals and reagent: Folin-Ciocalteu, Folin-Denis reagents, quercetin, gallic acid, tannic acid, 2,2-diphenyl-1-picrylhydrazyl (DPPH), and 2,4,6-tripyridyl-s-triazine (TPTZ) were purchased from Sigma Chemical Co. (USA) and Merck Chemical Supplies (Germany). All chemicals and solvents were of analytical grade.

The wall materials: maltodextrin, gum arabic, xanthan, and carrageenan were purchased, from LD Carlson, France.

2.2. Sample preparation and experimental design

The dried *Pouzolzia zeylanica* plants were extracted with water using airtight extractor (model GPA CC1-181907, Didatec Technologie France, 2007). The stirring rate, temperature, time and solution to solid ratio of extraction sample were maintained at 90 rpm, 81 °C, 30 min and 27:1 v/w, respectively. The extract was filtered by cloth and determined their volumes for experimental design.

The different three extract samples were prepared: (i) sample A was blended with maltodextrin and arabic; (ii) sample C was blended with maltodextrin and carrageenan; and (iii) sample X was blended with maltodextrin and xanthan gum before undergoing spray drying process. The content of maltodextrin and gum types was blended with the same ratio of 9% and 0.08 % (w/v). The laboratory scale spray dryer (SD-05, LabPlant™, UK) was used. The flow rate of drying air was fixed at 60 m³ h⁻¹ and the atomizing air was at a pressure of 1.1 bar, the inlet hot air temperature and feed flow speed of spray drying process were also kept at 180 °C and 18 rpm. All parameters in this study were based on optimal results of previous studies.
2.3. Analysis method of physicochemical properties

2.3.1. Powder product characteristics

Moisture content and water activity of the products were measured by using the analyzer (AND MS-50, Japan and Aqua lab 4TE, USA). The particle size and morphology of the different samples were evaluated by scanning electron microscopy (SEM) and measured by the particle analyzer (ZEOL-5500, Japan). The Hunter color system L (lightness), a (red-green) and b (yellow-blue) values, and total color difference (ΔE) of samples were measured by using a colorimeter (Konica Minolta, CR-400, Japan). The non-enzymatic browning (NEB) indices of samples were determined by measuring optical density (OD) values of ethanol extract of powder [2] through UV-VIS Spectrophotometer (Model SP-1920, Japan).

2.3.2. Bioactive compounds analysis and antioxidant activity evaluation

The anthocyanin content was determined by using the pH differential method, and the aluminum chloride colorimetric method was used for flavonoid determination, the polyphenol content was determined by folin-ciocalteu reagent method and tannin content was determined by folin-denis method. All results were shown in milligrams of cyanidin-3-glycoside equivalents (CE), quercetin equivalent (QE), gallic acid equivalents (GAE) and tannic acid equivalents (TAE) per gram of powder product, respectively [3-6]. The antioxidant activity of samples were determined following DPPH radical scavenging method [7]; the ferric reducing/antioxidant power was performed by FRAP method [8] and antioxidant ability index AAI was measured by total reducing power method [9].

2.4. Data analysis

Statistical analysis was performed based on factorial design at confidence level of 95% using Statgraphic Plus XVI. Significant difference of data means were calculated with a LSD through ANOVA analysis. All tests were done in triplicates.

3. RESULTS AND DISCUSSION

3.1. Effect of different gum types on stability of bioactive compounds of product samples

One of the important indices of spray drying process is good maintenance content of bioactive compounds in finished product. Results in Table 1 showed that different gum types had effect on bioactive compounds content of spray dried powder samples obtained (P < 0.05). The highest anthocyanin and flavonoid content were found in sample A (7.56 mgCE/100 g, 31.15 mgQE/g) and had statistically significant difference from others. However, the highest content of polyphenol was found in sample X (28.01 mgGAE/g) but not significantly different from sample A (27.96 mgGAE/g) and sample C (27.59 mgGAE/g) with P > 0.05. The highest tannin content was seen in sample C (27.98 mgTAE/g); but between sample C and sample X (26.73 mgTAE/g), sample X and sample A (25.79 mgTAE/g) there was not positive difference. According to Ravichandran et al. [7], the samples encapsulated with maltodextrin-arabic gum showed a 6 % increased stability of betalains, and with maltodextrin-xanthan gum, there was 21 % more stability than control. Result of Bandera et al. [8] showed different carriers had
Effect of different gum types on stability of antioxidant components …

different effect on retaining polyphenol content of Roselle powder samples. In the present study, the combination of maltodextrin and arabic gum carrier retained the content of bioactive compounds better than carrageenan and xanthan gum did. This can explain that arabic gum had the roles of both surface-active agent and drying matrix, thus preventing the loss of volatile exposed to the atmosphere and good retention volatile compounds [9].

Table 1. Content of bioactive compounds of samples with different added gum types.

| Gum types  | Anthocyanin (mgCE/100 g) | Flavonoid (mgQE/g) | Polyphenol (mgGAE/g) | Tannin (mgTAE/g) |
|------------|--------------------------|--------------------|----------------------|-----------------|
| Arabic     | 7.56 ± 0.106a            | 31.15 ± 1.035a     | 27.96 ± 0.380a       | 25.79 ± 0.530b  |
| Carrageenan| 5.62 ± 0.578b            | 28.36 ± 0.366b     | 27.59 ± 0.430a       | 27.98 ± 1.005a  |
| Xanthan    | 6.37 ± 0.793b            | 27.42 ± 0.855b     | 28.01 ± 0.800a       | 26.73 ± 0.275ab |

Notes: reported means (n = 3) and ± standard deviation. Means within a same column followed by the same letter were not significantly different (P < 0.05).

3.2. Effect of different gum types on antioxidant activity of product samples

The antioxidant potential was evaluated by measuring the decrease in DPPH radical absorption of samples from three types of different gum (Table 2). All samples were involved in the proton transfer with different degrees. This method evaluates the radical scavenging ability of a compound through its reaction with the stable DPPH radical. Concerning DPPH inhibition (%), three samples proved to have high antioxidant activities (between 75.55 and 72.83 %), with arabic sample was highest value (75.55 %) and carrageenan sample was lowest value (72.14 %). The similar, the ferric reducing ability of the samples was in 95.75±102.87 μM FeSO₄/g and 36.57±38.17 for FRAP and AAI, respectively (Table 2). The antioxidant potential of the samples was estimated from their ability to reduce TPTZ-Fe (III) complex to TPTZ-Fe (II). The FRAP value for the arabic sample was higher than other samples. However, the samples were not statistical difference (P > 0.05).

Table 2. The antioxidant activity of samples with different added gum types.

| Gum types  | DPPH (%)      | FRAP (μM FeSO₄) | AAI   |
|------------|---------------|-----------------|-------|
| Arabic     | 75.55 ± 0.65a | 102.87 ± 3.85a  | 38.17 ± 1.24a |
| Carrageenan| 72.14 ± 1.06b | 95.75 ± 2.39b   | 37.55 ± 1.79a |
| Xanthan    | 72.83 ± 1.28b | 97.39 ± 1.12ab  | 36.57 ± 0.96a |

Notes: reported means (n = 3) and ± standard deviation. Means within a same column followed by the same letter were not significantly different (p < 0.05).

3.3. Effect of different gum types on physic characteristics and nonenzyme browning indices of product samples

The analysis of physical characteristics of powders including water activity, moisture content, particle size and nonenzyme browning index were shown in Figure 1. Water activity (a_w) is an important factor which could give a good indication of the powder shelf life. It has
been well known that most of foods with $a_w$ less than 0.6 are stable toward microorganisms and biochemical reactions. Besides, water activity varies with moisture content as it measures the availability of free water in a food system which is responsible for any biochemical reaction, but the moisture content represents the composition of water in a food system [10]. In this study $a_w$ for three powder samples were 0.514, 0.565 and 0.591, respectively (Figure 1a). There was significant difference between samples ($P < 0.05$). Whereas, the moisture content of samples were around 6.42±6.67% (Figure 1b) and between samples were not significant difference ($P > 0.05$).

![Figure 1](image)

*Figure 1.* Plots showed water activity (a), moisture content (b), particle size (c) and NEB (d) of samples with different gum types.

*Note:* Error bars indicate the standard deviation of the mean values.

The average particle size of A, C and X samples were 6.26, 6.32 and 6.51 µm, respectively. There was significant difference between X and A, B samples ($P < 0.05$) but between A and B was no significant difference (Figure 1c). Similar result for nonenzyme browning (NEB) index of samples was shown in Figure 1d, NEB index had the highest value was found in X sample (0.363) and had significant difference from others. And A sample had the lowest NEB index (0.298). According to Altamirano *et al.* [11], it was necessary to apply arabic gum and maize starch to the garambullo concentrate in order to avoid caramelization of the remaining sugars present in the extract of the pigment and to avoid its sticking to the walls of the dryer.
The analysis of the surface of powder particles were carried out using SEM. Figure 2 showed the SEM micrographs of the powders produced with different encapsulating agents. The resulting powders had a particle size from 3 to 30 µm. It was found that most of particles produced looked like spheres with dents on surface. In addition, particles in arabic gum sample had more uniform size than carrageenan and xanthan gum did. The particles in carrageenan sample seemed to have smoother surface than arabic and xanthan gum samples. According to Namazkar and Ahmad [12], some pseudoplastic properties of carrageenan allow it to act as a plasticizer and make the formation of spherical and smooth-surface microparticle more desirable.

![SEM micrograph of spray drying powder samples with different gum types](image)

Figure 2. SEM micrograph of spray drying powder samples with different gum types.

### 3.4 Effect of different gum types on the color values of product samples

The color is defined in the terms of luminosity (L), red versus green (a) and yellow versus blue (b). Total color difference (ΔE) was measured by mathematical equation, \( \Delta E = [(L_0-L)^2 + (a_0-a)^2 + (b_0-b)^2]^{1/2} \). The results of the color measurement for powder samples are shown in Table 3. It was found that the color values (L, a, b, and ΔE) of A, C and X samples had a significant effect (p < 0.05). Encapsulated powder with carrageenan had the highest L and b values, followed by xanthan and arabic. However, a and ΔE values of carrageenan were lowest. The higher a and ΔE for arabic and xanthan samples could have relation between color values and bioactive compounds content in powder samples.

| Gum types   | L       | a       | b       | ΔE       |
|-------------|---------|---------|---------|----------|
| Arabic      | 78.43 ± 0.189\textsuperscript{b} | 7.55 ± 0.065\textsuperscript{a} | 6.96 ± 0.180\textsuperscript{b} | 18.86 ± 0.580\textsuperscript{a} |
| Carrageenan | 79.79 ± 0.085\textsuperscript{a} | 6.98 ± 0.040\textsuperscript{b} | 7.30 ± 0.080\textsuperscript{a} | 17.82 ± 0.157\textsuperscript{b} |
| Xanthan     | 78.52 ± 0.103\textsuperscript{b} | 7.57 ± 0.030\textsuperscript{a} | 6.64 ± 0.025\textsuperscript{c} | 18.62 ± 0.245\textsuperscript{a} |

Notes: reported means (n = 3) and ± standard deviation. Means within a same column followed by the same letter were not significantly different (P < 0.05).

### 4. CONCLUSION

Pouzolzia zeylanica powder that was produced by using mixture of maltodextrin with arabic, carrageenan and xanthan gum had significant difference from retaining content of bioactive compounds, antioxidant activity, the color values (L, a, b and ΔE), nonenzyme
browning (NEB), moisture content, water activity, particle size and morphology of finished products. In this study, the sample blended with maltodextrin and arabic gum was evaluated more optimal sample than others because of its maintaining content of high bioactive compounds and antioxidant activity, small and uniform particle size, low water activity and moisture content. These are necessary to further study of stability, handling, preservation and store of product in the future.

REFERENCES

1. Barbosa M. I. M. J., Bosarelli C. D., Mercadante A. Z. - Light stability of spray dried bixin encapsulated with different edible polysaccharide preparations, Food Res Int 38 (8-9) (2005) 989-994.
2. Assawarachan R., Noomhorm A. - Effect of operating condition on the kinetic of color change of concentrated pineapple juice by microwave vacuum evaporation, Journal of Food Agriculture & Environment 6 (3-4) (2008) 47-53.
3. Ahmed J. K., Salih H. A. M., Hadi A. G. - Anthocyanins in red beet juice act as scavengers for heavy metals ions such as lead and cadmium, International Journal of Science and Technology 2 (3) (2013) 269-273.
4. Mandal S., Patra A., Samanta A., Roy S., Mandal A., Mahapatra T. D., Pradhan S., Das K., Nandi D. K. - Analysis of phytochemical profile of Terminalia arjuna bark extract with antioxidant and antimicrobial properties, Asian Pacific Journal of Tropical Biomedicine 3 (12) (2013) 960-966.
5. Hossain M. A., Raqmi K. A. S., Mijizy Z. H., Weli A. M., Riyami Q. - Study of total phenol, flavonoids contents and phytochemical screening of various leaves crude extracts of locally grown Thymus vulgaris, Asian Pacific Journal of Tropical Biomedicine 3 (9) (2013) 705-710.
6. Laitonjam W. S., Yumnam R., Asem S. D., Wangkheirakpam S. D. - Evaluative and comparative study of biochemical, trace elements and antioxidant activity of Phlogacanthus pubinervius T. Anderson and Phlocanthus jenkinii C.B. Clarke leaves, Indian Journal of Natural Products and Resources 4 (1) (2013) 67-72.
7. Aluko B. T., Alli S. Y. R., Omoiyeni O. A. - Phytochemical analysis and antioxidant activities of ethanolic leaf extract of Brilliantsaisa patula, World Journal of Pharmaceutical Research 3 (3) (2014) 4914-4924.
8. Adedapo A. A., Jimoh F. O., Afolayan A. J., Masika P. J. - Antioxidant properties of the methanol extracts of the leaves and stems of Celtis africana, Rec Nat Prod 3 (1) (2009) 23-31.
9. Nguyën T. M. T. - Quy trình chế tác các hoạt chất sinh học từ năm linh chi (Ganoderma lucidium), Tap chí Khoa học và Công nghệ 47 (1) (2009) 45-53.
10. Ravichandran K., Palaniraj R., Saw N. M. M. T., Gabr A. M. M., Ahmed A. R., Knoor D., Smetanska I. - Effects of different encapsulation agents and drying process on stability of betalains extract, J Food Sci Technol 51 (9) (2014) 2216-2221.
11. Bandera D. D., Carvajal A. V., Garcia O. D., Salazar B. Q., Lopez A. D. - Assessing release kinetics and dissolution of spray-dried Roselle (Hibiscus sabdariffa L.) extract encapsulated with different carrier agents, LWT-Food Science and Technology 64 (2015) 693-698.
TÔM TÁT

ÁNH HƯỞNG CỦA CÁC LOAI GUM KHÁC NHAU ĐẾN THÀNH PHẦN CHỐNG OXY HÒA VÀ CÁC ĐẠC TÍNH VẤT LÝ CỦA BỘT THUỘC ĐỞI SÀY PHUN

Nguyễn Duy Tân1,2*, Nguyễn Minh Thùy1

1. Khoa Nông nghiệp và Tài nguyên thiên nhiên, Trường Đại học An Giang, 18 Ung Văn Khiêm, Phường Đông Xuyên, Thành phố Long Xuyên, tỉnh An Giang, Việt Nam
2. Khoa Nông nghiệp và Sinh học ứng dụng, Trường Đại học Cần Thơ, Khu II, Đường 3/2, Phường Xuân Khánh, Quận Nghĩa Kiều, Thành phố Cần Thơ, Việt Nam

*Email: ndtan@agu.edu.vn

Mục tiêu của nghiên cứu là khảo sát sự ảnh hưởng của việc phối chế ba loại gum khác nhau (arabic, carrageenan và xanthan) vào dịch trích thuốc để cùng với maltodextrin như là vật liệu tạo vị nang trong quá trình sấy phun để sử ổn định các thành phần chống oxy hóa (anthocyanin, flavonoid, polyphenol, tannin) và hoạt động chống oxy hóa thông qua khả năng khử gốc tự do DPPH, khả năng khử soát FRAP, chỉ số chống oxy hóa AAI; và các đặc tính vật lý (hãm ổn, hoạt độ nước, kích thước và hình dạng hạt, cũng như màu sắc, sự hòa nâu không enzyme) của sản phẩm. Kết quả chỉ ra rằng, màu sắc được phối chế với gum arabic và maltodextrin duy trì tốt các hợp chất sinh học và cho bất sản phẩm có các đặc tính chất lượng tốt hơn các mẫu khác. Ở mẫu tới tay này, hàm lượng anthocyanin, flavonoid, polyphenol và tannin xác định được là 7,56 ± 0,106 mgCE/100 g; 31,15 ± 1,035 mgQE/g; 27,96 ± 0,380 mgGAE/g; 25,79 ± 0,530 mgTAE/g. Hoạt động chống oxy hóa thông qua DPPH, FRAP và AAI được xác định là 75,55 ± 0,65 %, 102,87 ± 3,85 µM FeSO₄/g and 38,17 ± 11,24. Hàm ổn, hoạt độ nước, kích thước hạt, giá trị màu sắc (L, a, b), sự khác màu total (ΔE) và sự hòa nâu không enzyme (NEB) xác định được lần lượt là 6,42 ± 0,085 %; 0,5142 ± 0,0076; 6,26 ± 0,110 µm; 78,43 ± 0,189; 7,55 ± 0,065; 6,96 ± 0,180; 18,85 ± 0,580 và 0,298 ± 0,015.

Tiếouro: hoạt hóa chống oxy hóa, màu sắc, các loại gum khác nhau, đặc tính vật lý, bộ thuốc đổi đời sấy phun.