Physicochemical Properties of Spray-Dried Young Coconut Juice

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***Abstract*—Objective: To evaluate physicochemical properties, antioxidant activity and phytochemical determinations of Young Coconut Juice (YCJ) from *Cocos nucifera* L. (Arecaceae) and spray-dried maltodextrin (MD) mixed YCJ powder (MD-YCJ powder).Methods: YCJ and spray-dried YCJ in various concentrations 0-20% (w/v) of MD were studied on physical properties, chemical properties, antioxidant activity and phytochemical determinations. Results: YCJ and reconstituted spray-dried YCJ were significant ($p<0.05$) difference in physicochemical properties (color, pH, total soluble solids and transmittance).Water activity (a_w) of spray-dried YCJ products were significant ($p<0.05$) difference. Antioxidant activity of YCJ and spray-dried YCJ in various concentrations 0-20% (w/v) of MD were studied. The isolated compound of spray-dried YCJ and spray-dried MD-YCJ powder (20%, w/v), *β*-sitosterol, was separated, identified and confirmed by comparison of their physical properties (TLC, HPLC chromatogram, melting point*)*.The quantitative analysis of *β*-sitosterol in YCJ and selected spray-dried YCJ powder (calculated as 1 coconut fruit, 350 ml) using suitable HPLC conditions were 89.12±7.76 and 12.31±2.50 *μ*g, respectively. Conclusion: Spray-dried technique was selected and used as drying process of YCJ. MD was used as encapsulating agent to dried powder. Spray-dried MD-YCJ powder 20% (w/v) was selected to future study because of their good physical appearance, physicochemical properties, antioxidant activity and good stability.**

***Index Terms*—young coconut juice, spray-dried young coconut juice, physicochemical properties, antioxidant activity, phytochemical properties**

I. Introduction

Young Coconut Juice (YCJ), the liquid endosperm of young coconut from *Cocos nucifera* L., Arecaceae, was obtained from aromatic green dwarf variety. YCJ is highly rich in nutritional (sugars, vitamins, minerals, amino acids), phytochemical (polyphenol, phytosterols and phytohormones) [1] and therapeutic properties (antioxidant, antibacterial, antidote, hepatoprotective, hypoglycemic, cardioprotective, delaying osteoporosis, reduce risk of Alzheimer's disease, wound healing and estrogen-like effect [2]-[4]. YCJ has been prepared in dry form because of the storage and handling problems. Drying procession can be product manufacture of YCJ powder, for example freeze drying YCJ powder [5].One of the most commonly drying process is spray drying, widely used in commercial production of milk powders, vegetable and fruits [6], [7]. Maltodextrin (MD), encapsulating agent, was use for encapsulate YCJ powder. In this study, YCJ, spray-dried YCJ powder and spray-dried MD-YCJ powder were further studied on antioxidant activities, phytochemical, physical, and chemical properties.

II. Materials and Methods

A. Chemicals

All the chemicals used in these experiments were analytical grade and purchased from Labscan Asia (Bangkok, Thailand). Maltodextrin DE 10(MD) was purchased from Zhucheng Dongxiao Biotechnology Co., Ltd., (China).

B. Preparation of Young Coconut Juice

Young Coconut Juice (*Cocos nucifera* L., Arecaceae) was obtained from aromatic green dwarf variety of fresh young coconut fruits (6-7 months) from Hat Yai District, Songkhla Province, Thailand. It was then pooled and analyzed within 48 hours after harvest. The clear YCJ was kept sealed in plastic bag and stored at -20 °C before used.

C. Preparation of Spray Dried Young Coconut Juice

Encapsulation YCJ was prepared by mixed with MD in various concentrations (0, 5, 10, 15 and 20 %, w/v), respectively. After that, spray drying process including dispersion process of the core material in entrapment material, follow by atomization and spray the mixture in hot air desiccant into a chamber. The YCJ encapsulated mixtures were sprayed and dried using Buchi Mini spray

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dryer B-191 (Switzerland). The spray dryer was operated inlet and outlet temperature at 150 °C and 67 °C, respectively. The air flow was 50 mm and feed rate was 3 ml/min. The percentage of yield was calculated. Spray-dried YCJ powder and spray-dried MD-YCJ powder was collected and kept in well-closed container and protect from light at -20 °C until further analysis.

D. Evalution of Physical and Chemical Properites

1) Physical properites

Color parameters (Hunter L*, a* and b* values) of YCJ, reconstitute spray-dried YCJ powder and reconstitute spray-dried MD-YCJ powder were determined using a spectrophotometer-colorimeter (HunterLab, ColorQuest XT, USA) and expressed as L*, a* and b* values. L* as lightness from zero (black) to 100 (white); a* as redness when positive, gray when zero, and greenness when negative and b* refers to yellowness when positive, gray when zero, and blueness when negative. These parameters were determined in triplicate.

2) Chemical properites

The chemical properties of YCJ, reconstitute spray-dried YCJ powder samples were evaluated as follows. Total soluble solid was determined with refractometer (Precision instruments, England). Acid-base was analyzed using pH meter (Mettler-Toledo, Switzerland). Transmittance of all YCJ samples was determined using a spectrophotometer (HunterLab, ColorQuest XT, USA) at 610 nm (relative to distilled water) [8].Water activity (a_w) of spray-dried YCJ powder these samples were determined by using a water activity meter (Aqualab, Series, USA) at room temperature. All of examinations were determined in triplicate.

E. Antioxidant Activity

Antioxidant activities of reconstitute spray dried YCJ powder and spray-dried MD-YCJ powder were evaluated by DPPH radical scavenging assay. The DPPH radical scavenging activity was measured by the 2,2- diphenyl-1-picrylhydrazil (DPPH) according to a modified method [9-10]. For the modified method, spray-dried YCJ powder and spray-dried MD-YCJ powder were dissolved in distill water and diluted for at least five dilutions. The solutions (100 µl) were mixed to an equal volume of 6 x 10 -5 M DPPH (in 70% EtOH) in 96-well plate. After a 30 minute incubation period at room temperature, the mixture was measured in 96-well microplates (Power WaveX, Biotek) at the absorbance of 517 nm. L (+) Ascorbic acid (RFCL Limited, India) was used as a positive control in the same condition. The result was calculated as the effective concentration of sample required scavenging DPPH by 50% (EC50 value).

F. Phytochemical Determinations

1) Extraction

Fresh YCJ (350 ml) and reconstituted spray-dried YCJ powder (10 g) are extracted with CH_2CL_2(5 X 20 ml). Then, the pooled CH_2CL_2 extract was evaporated under reduced pressure to give dried crude CH_2CL_2 extract. This extracts are kept in well-closed containers protected from light before used [5].

2) Isolation and identification

Each sample of dried crude CH_2Cl_2 extract was purified by column chromatography (silica gel, 200 g). Elution was accomplished with a gradient of n-hexane/EtOAc/MeOH. A total of 200 fractions (fraction size 20 ml) were collected and combined on the basis of the TLC profiles after detection with UV lamp and 50% sulfuric acid in EtOH spraying reagent. The isolated compound, *β*-sitosterol, was collected and identifies from previous study [5].

3) Thin Layer Chromatography (TLC)

The standard *β*-sitosterol (2 µg) (in house, PSU, Thailand) and the CH_2CL_2 extract of YCJ and spray-dried YCJ (500 µg) were dissolved in chloroform and then subjected to thin layer chromatography (Merck, Germany) using silica gel as stationary phase and hexane-ethyl acetate (90:10, 80:20, 60:40, v/v) as mobile phase. After developed, the TLC plate was dried at room temperature and sprayed with 50% sulfuric acid in 95% EtOH and subsequently heated at 80-100 °C for 10 minute. Purple color spot appeared coinciding with those of standard samples of *β*-sitosterol.

4) HPLC analysis

HPLC analysis was performing follow as previous study [5]. The chromatographic condition was using Agilent 1100 series equipped with photodiode-array detector (PDA) and auto sampler (Palo Alto, CA). The chromatographic conditions were obtained using a Vertisep™ USP C18 HPLC column (150 x 4.6 mm, 5 µm) (Vertical Chromatography Co., Ltd., Thailand) under isocratic conditions with 100% MeOH as the mobile phase at the flow rate of 1.0 ml/min. The quantification wavelength of detector was set at 208 nm.

G. Statistical analysis

At least three replicate analyses were carried out and the results were report as means ± SD. The data was statistically tested by one-way analysis of variance (ANOVA). Statistical significant difference was established at $p<0.05$.

III. Results and Discussion

A. Physical appearence

The % yield of spray-dried YCJ powder and spray-dried MD-YCJ powder at concentrations 5-20% (w/v) are showed in Table I. The physical appearance of spray-dried MD-YCJ powder at concentrations 10, 15 and 20% (w/v) was observing as homogenous white powder as show in Fig. 1. Spray-dried MD-YCJ powder 5 % (w/v) was not show because it melts, caking and agglomeration in 1 hour after storage at room temperature (30±2°C).Due to the storage problems of YCJ, MD was used to encapsulated YCJ to dried powders and can storage at room temperature without melting and agglomeration. Spray-dried MD-YCJ powder 20% (w/v) was selected to future study because it cans storage at room temperature after 30 days.

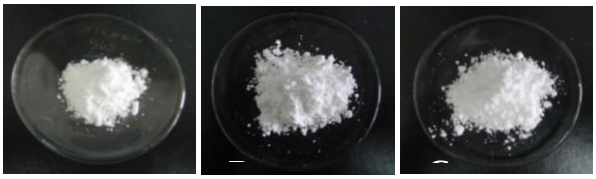

Figure 1. Spray-dried MD-YCJ powder at various concentrations A 10%, 15%, C 20% (w/v of MD).

B. Physicochemical determinations

The physicochemical properties of YCJ and spray-dried YCJ powder are showed in Table II. For the color measurement, the results of YCJ and reconstitute spray-dried YCJ powder were significant ($p<0.05$) difference. Moreover, there were significant ($p<0.05$) difference in physicochemical properties including pH value, total soluble solids (°Brix), and transmittance between YCJ, reconstituted spray-dried YCJ powder and reconstituted spray-dried MD-YCJ powder. Water activity (a_w) of spray-dried YCJ powder and spray-dried MD-YCJ powder were significant ($p<0.05$) difference. Water activity (a_w) is an important factor affecting the stability of dehydrated products that was decrease when using MD as the material encapsulated for produce spray-dried YCJ powder and spray-dried MD-YCJ powder 20% (w/v) has lowest water activity. Spray-dried MD-YCJ powder 20% (w/v) was selected to future study because of the physical appearance, physicochemical qualities and good stability.

TABLE I. THE % YIELD OF SPRAY-DRIED YCJ POWDER AND MD-YCJ POWDERS AT 5% - 20% (W/V)

Spray dried YCJ powder	% yield
YCJ powder	1.05 ±0.58 %
MD-YCJ powder 5 % (w/v)	1.34 ±0.69 %
MD-YCJ powder 10 % (w/v)	5.76 ±1.07 %
MD-YCJ powder 15 % (w/v)	6.70 ±0.65 %
MD-YCJ powder 20 % (w/v)	7.33 ±1.29 %

Each data represents the mean ±S.D. (n = 3)

TABLE II. PHYSICOCHEMICAL PROPERTIES OF YCJ, RECONSTITUTE SPRAY-DRIED YCJ POWDERSPRAY-DRIED YCJ POWDER AND SPRAY-DRIED MD-YCJ POWDERS AT 5 % - 20 % (W/V).

Physicochemical properties	YCJ	Spray-dried MD-YCJ powder (%, w/v)					
		0	5	10	15	20	Ascorbic acid
Color parameters							
L* value	100.78±0.21^{a}	98.40±0.79^{b}	98.08±0.09^{b}	98.13±0.23^{b}	96.59±0.15^{c}	97.83±0.58^{b}	-
a* value	-0.14±0.01^{a}	0.09±0.01^{b}	0.05±0.01^{c}	0.02±0.01^{d}	0.04±0.01^{c}	0.05±0.01^{c}	-
b* value	-0.12±0.01^{a}	0.58±0.01^{b}	1.12±0.01^{c}	1.12±0.01^{c}	1.09±0.01^{d}	1.12±0.01^{c}	-
pH value	4.87±0.01^{a}	4.99±0.16^{b}	5.01±0.01^{b}	5.01±0.01^{b}	5.02±0.00^{b}	5.04±0.01^{b}	-
Total soluble solid (°Brix)	7.23±0.03^{ab}	7.98±1.81^{b}	12.02±0.13^{c}	15.08±0.08^{c}	19.13±0.03^{bc}	22.05±0.05^{bc}	-
Transmittance (%)	97.89±0.34^{a}	96.56±0.88^{bc}	96.10±0.35^{c}	97.73±0.17^{a}	97.56±0.33^{ab}	96.58±0.88^{bc}	-
Water activity (a_w)	N/A	0.42±0.01^{a}	0.40±0.00^{b}	0.32±0.01^{c}	0.29±0.01^{d}	0.24±0.01^{e}	-
Antioxidant activity (EC_{50})	-	5.56±0.03 (mg/ml)	9.23±0.03 (mg/ml)	16.32±0.02 (mg/ml)	27.16±0.04 (mg/ml)	36.32±0.01 (mg/ml)	3.25±0.01 (µg/ml)

N/A = not available.
Each data represents the mean ±S.D. (n = 3).
a-d: means in the same row with different superscript letter differ significantly ($p<0.05$).

C. Antioxidant Activity

The effective concentration of YCJ, spray-dried YCJ powder and spray-dried MD-YCJ powder 5-20% (w/v) required to scavenge DPPH by 50% (EC_{50} value) obtained by linear regression analysis of dose responds curve plotting between % inhibition and concentrations. Table II showed the EC_{50} value of YCJ, spray-dried YCJ powder and spray-dried MD-YCJ powder 5-20% (w/v) that were decreased due to the amount of MD was increase. Spray-dried YCJ powder had many chemical constituents such as caffeic acid [11], (+)-catechin and (-)-epicatechin [12], which affect the free radical scavenging activity of spray-dried YCJ powder. Antioxidant activities of polyphenolics derived from plants have claimed beneficial health functions for retarding aging and preventing cancer and cardiovascular diseases [13].

D. Determination of Phytochemical Analysis

After extraction, a β-sitosterol was isolated, identified and confirmed by comparison of their physical properties (TLC, HPLC, melting point (MP =135-136 °C)) and spectral data with those reported in the literature [5] [14].

The CH_2Cl_2 extract of YCJ, spray-dried YCJ powder and spray-dried MD-YCJ powder were subjected to thin layer chromatography. After developed, a spot showed pink color that coincided with that of the reference β-sitosterol. R_f values of β-sitosterol isolated from the all samples were carried out with R_f value of standard β-

sitosterol. R_f values of β-sitosterol in three mobile phases were 0.13, 0.29 and 0.77, respectively.

HPLC is a suitable analytical method for determining β-sitosterol in YCJ, reconstituted spray-dried YCJ and spray-dried MD-YCJ powder 20% (w/v).The HPLC chromatogram of β-sitosterol, YCJ and spray-dried MD-YCJ powder 20% (w/v) were performed in normal phase using C18 column as stationary phase and MeOH as mobile phase. The retention times of standard and samples were obtained in 16.2 - 16.5 minute. The quantitative analyses of β-sitosterol in YCJ and spray-dried MD-YCJ powder20%(w/v) (calculated as 1 coconut fruit, 350 ml) using suitable HPLC conditions were 89.12 ± 7.76 and 12.31 ± 2.50 µg, respectively.

IV. Conclusion

Spray-dried technique was used as drying process of YCJ. Maltodextrin was added for encapsulate YCJ. The spray-dried product of MD-YCJ was considered to be the good technique to dry YCJ on the result of phytochemical determination, physical and chemical properties and antioxidant activity.

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Conflicts of Interests

All authors have none to declare.

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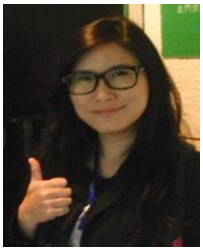

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