

Antioxidant Capacity and Phenolics of Spray Dried *Arenga pinnata* Juice Powder

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Abstract: The ferric reducing antioxidant power, total phenolic content, radical scavenging activity, amino acid content and sugar content of spray dried *Arenga pinnata* juice powder were evaluated to determine the quality of spray dried powder obtained by spray drying of fresh *Arenga pinnata* juice at inlet temperature of 130 °C, feed flow rate of 350 mL/h, outlet temperature of 70 °C and maltodextrin 10 DE addition at 20%. Powder obtained has a total phenolic compounds content of 5.82 mg/100 g of gallic acid equivalent (GAE) and antioxidant potential identified by free radical scavenging activity (IC₅₀) was 0.6 µmol/g. The total sugar content of *Arenga pinnata* powder resulted in 30.14%. The analysis of free amino acids depicted the presence of lysine, glutamic acid, aspartic acid and alanine at higher levels. The nutritional profile of the powder is vital in delivering beneficial properties when reconstituted into juice.

Key words: *Arenga pinnata*, antioxidant activity, phenolic compounds.

1. Introduction

Arenga pinnata is the most versatile palm specie, because almost all parts of the tree can be used with the sap being the most important product [1, 2]. Palm sap is consumed fresh as juice in local communities in Southeast Asia, because it is believed to be highly nutritious and a good antioxidant.

Antioxidants are molecules that inhibit the oxidation of other molecules that can produce free radicals leading to chain reactions that may damage cells [3]. Generally, fresh sap juice obtained from *Arenga pinnata* tree is sweet, oyster white colour and translucent with nearly neutral pH. The quality of sap juice is affected during storage by the pH of sap and reducing sugar content. Microorganisms use sugars in the sap as an energy source to produce organic acids.

Spray drying is a method of producing a dry powder from a liquid or slurry by rapidly drying with a hot gas in a single processing step, which can be

advantageous for profit maximization and process simplification [4, 5]. It is useful as a method to transfer those molecules responsible for sensory and or biofunctional properties to a solid phase, which will be able to enhance their stability and control their release in food matrices [6]. The advantages of a dried powder over conventional liquid forms of juice are lower storage costs, a higher concentration and the stability of active substances. Spray dried Juice powder offers several advantages to protect sensitive food components against unfavourable ambient condition, mask or preserve flavours and aromas, reduce volatility and reactivity and also provide additional attractiveness for the merchandising of food products. Spray drying has been widely utilized for the commercial production of fruit juice powders. Thus, the present study was carried out to assess the antioxidant capacity of spray dried *Arenga pinnata* powder with emphasis on ferric reducing antioxidant power, total phenolic content, radical scavenging activity, amino acid content and sugar content of spray dried *Arenga pinnata* juice powder.

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2. Materials and Methods

2.1 Juice Preparation

Samples were prepared with concentrated sugar palm (*Arenga pinnata*) juice. Fresh sugar palm juice tapped from sugar palm tree (*Arenga pinnata*) was collected locally at Serdang, Malaysia. Food grade maltodextrin 10 DE was sourced locally and added as drying aids.

2.2 Obtaining Powders by Spray Drying

Spray drying was carried out with a spray dryer lab plant SD-05 (West Yorkshire, UK), comprising of spray chamber of 1,050 mm × 620 mm × 500 mm and 0.5 mm standard diameter nozzle with co-current flow. The spray drying was conducted at inlet air temperature 130 °C, pump speed 350 mL/h, outlet air temperature 70 °C and maltodextrin addition at 20%. Ambient temperature was maintained at 27 °C and relative humidity of 56% ± 1%. The dryer was washed with water at the desired parameter setting for 10 min before and after the spray drying process. Spray dried powders were collected in clean container with known weight and kept inside the desiccators until it cooled down. Powders were then weighed, sealed in bottle and stored at 4 °C for analysis.

2.3 Ferric Reducing Antioxidant Power (FRAP) Assay

FRAP assay was performed according to method of Buasod [7]. 500 µL of the samples were added to 1.25 mL of phosphate buffer and 1.25 mL of potassium ferricyanide (1%). The mixtures were incubated at 50 °C for 20 min and then 1.25 mL of trichloroacetic acid solution (10%) was added. Then, the mixture was combined with 1.25 mL of deionized water and 0.25 mL of FeCl₃ (1%). The ferric-tripyridyltriazine (Fe³⁺-TPTZ) complex having an intense blue colour was measured by reading the absorbance at 595 nm. Results were expressed as µmol of gallic acid per g of sample.

2.4 2,2-Diphenyl-1-Picrylhydrazyl (DPPH) Radical Scavenging Activity

DPPH radical scavenging activities were determined on the base of a method developed by Mansouri et al. [8]. A sample (1.5 mL) was added to 1.5 mL of 0.15 mM DPPH in methanol. The mixture was vortexed and allowed to stand at room temperature at 25 ± 2 °C in dark light for 60 min. The absorbance of the resulting solution was measured at 517 nm using a UV-visible spectrophotometer (Ultrospec 3100 Amershan Biosciences). The blank was prepared in the same manner, except the distilled water was used instead of sample. Percentage of DPPH radical inhibition was calculated according to Eq (1):

$$\% \text{ DPPH inhibition} = \left[\frac{(A_c - A_s)}{A_c} \right] \times 100 \quad (1)$$

where, A_s is the absorbance of sample solution and A_c is the absorbance of the DPPH solution.

2.5 Determination of Total Phenolics Content

Total phenolics content of the extracts was determined according to the method developed by Singleton and Rossi [9]. In brief, 100 µL aliquot of the extract was added to 2 mL of 20 g/L Na₂CO₃ solution. After 2 min, 100 µL of 50% Folin-Ciocalteu reagent was added, and the mixture was allowed to stand for 2 h at 25 °C. The absorbance was measured at 750 nm using a spectrophotometer (UV 1601, Shimadzu Co., Ltd., Kyoto, Japan). The total phenolics content was determined using the standard gallic acid calibration curve and the results were expressed as milligram gallic acid equivalents per gram sample dry weight (mg GAE/g DW).

2.6 Determination of Type and Concentration of Sugar

The type and concentration of sugar were determined using high performance liquid chromatography (HPLC) (Shimadzu, CR6A Chromatopac) with a NH₂ HPLC column (4.6 mm ×

250 mm, 5 μ m particle size, Lichrosorb NH₂ Merck, Germany, thermostated at 30 °C), and a refractive index (RI) detector was used for detection of sugar peaks. The mobile phase used was the solution of acetonitrile and water (85:15), pumped at a flow rate of 1.5 mL/min and injection volume 20 μ L. The samples were prepared by making appropriate dilutions with distilled water. All sample solutions were passed through a 0.45 μ m syringe filter (nylon) to remove particulates prior to HPLC analysis. D-glucose, D-fructose and sucrose were used as external standards.

2.7 Amino Acid Determination

The amino acids were separated by reverse-phase HPLC column (waters Milford, MA) controlled by a breeze system (waters). The hydrolysates were injected in a pre-column derivatized with 6-aminoquinolyl-N-hydroxysuccinimidyl carbamate (ACCQ) to determine primary amino acids. The separation of amino acids was performed on a waters AccQ-Tag (3.9 mm \times 150 mm). The mobile phases used were solvent A (1: 10 ratio AccQ-Tag Eluent A concentrate commercial to deionized water) and solvent B was 60% (v/v) acetonitrile solutions. The injection volume was 100 μ L and a flow rate of 1 mL/min was used. For the determination of tryptophan, the hydrolysates were separated on a waters C₁₈ column (3.9 mm \times 300 mm) using the same mobile phase. The fluorescent detector was adjusted at excitation wavelength of 250 nm and emission wavelength of 395 nm. All reagents used were HPLC grade. Amino acids were quantified by comparing peak area of the samples with those of the internal standard, AABA.

3. Results and Discussion

In general, antioxidant activity is derived from phenolic compounds and/or vitamins [10]. *Arenga pinnata* sap juice is believed to have phenolic content which can act as antioxidant. The potency of the

antioxidant property could be affected by the spray drying process. In this study, the widely-used DPPH inhibition and FRAP assays have been applied and data obtained are as reported in Table 1.

The total phenolic content in *Arenga pinnata* juice powder refers to the total amount of phenolic compounds present in the powder after spray drying. The phenolic compounds were found to contain 5.82 mg of GAE/100 g of total phenolic. Naknean and Meenune [11] studied the characteristics and antioxidant activity of palm sugar syrup produced by thermally heating the palm sap. The phenolic content of palm sugar (*Borrassus flabellifer* Linn.) samples obtained after heating fresh sap was found to range from 1.35 mg GAE to 2.21 mg GAE/100 g of sample. Naturally fresh palm sap contains phenolic compounds. Aeimsard et al. [12] studied the effect of vacuum drying on total phenolic compounds, antioxidant activities and physical properties of palm sugar. The total phenolic content was 214 mg GAE/100 g dry weight. Hence, spray drying is preferred for the stability of phenolic compounds. Increase of total phenolic content may enhance the action of radical scavenging activity. The antioxidant activity comes from the hydroxyl group of polyphenols that can be quenched by DPPH radicals at immediate stages of oxidation or the formation of new compounds with higher antioxidant activity.

Phenolic content is interrelated closely to the DPPH radical scavenging activity. The DPPH inhibition of *Arenga pinnata* juice powder range from 26.81% to 28.74% inhibition. Naknean and Meenune [11] reported the DPPH radical scavenging activity of thermally heated palm sap syrup ranged from 13.27 μ mol trolox equivalent (TE) to 18.49 μ mol TE/g of sample. While, Aeimsard et al. [12] reported the DPPH inhibition at 43.33%. The antioxidant activity of phenolic compounds is clearly related to free radical scavenging and hydrogen-donation ability. The ferric reducing antioxidant power varied between 0.539 μ mol/g and 0.550 μ mol/g of powder. Aeimsard et al.

Table 1 Antioxidant capacity of spray dried *Arenga pinnata* powder.

Total phenolic content GAE (mg/100 g)	DPPH (% inhibition)	FRAP value ($\mu\text{mol/g}$)
5.82-5.83	26.81-28.74	0.539-0.550

Table 2 Sugar profile of *Arenga pinnata* powder.

Fructose (g/100 g)	Glucose (g/100 g)	Sucrose (g/100 g)	Maltose (g/100 g)
ND (< 0.001)	ND (< 0.001)	29.16-31.11	ND (< 0.001)

ND: not detected.

Table 3 Amino acid profile of *Arenga pinnata* powder.

No.	Amino acid	g/100 g
1	Hydroxyproline	0.004-0.010
2	Aspartic acid	0.102-0.096
3	Serine	0.068-0.071
4	Glutamic acid	0.242-0.245
5	Glycine	0.050-0.051
6	Histidine	0.000-0.000
7	Arginine	0.048-0.055
8	Threonine	0.031-0.032
9	Alanine	0.093-0.095
10	Proline	0.025-0.029
11	Thyrosine	0.005-0.028
12	Valine	0.022-0.029
13	Methionine	0.014-0.041
14	Lysine	0.218-0.224
15	Isoleusine	0.018-0.021
16	Leusine	0.012-0.015
17	Phenylalanine	0.008-0.008

[12] similarly reported that ferric reducing antioxidant power was at 1.11 $\mu\text{mol/g}$ for vacuum dried palm sugar.

The sugar profile of *Arenga pinnata* powder was ascertained. Quantities of glucose, fructose, maltose and sucrose were determined and data are compiled in Table 2. The major saccharide was sucrose ranging from 29.16 g/100 g to 31.11 g/100 g of sample. Exceptionally, high amounts of sucrose were found, but glucose, fructose and maltose levels were extremely low and not detected. Similar results were reported by Naknean and Meenune [11] in the characterisation of palm sugar syrup obtained by heating. The most abundant sugar found in palm sugar syrup was sucrose (59.15%), glucose (4.01%) and fructose (4.44 %). It is obvious that sucrose was in abundance.

Relative quantities of free amino acids in *Arenga pinnata* powder determined by Accq-Tags waters method are compiled in Table 3. Varying kind and quantities of free amino acid was detected in the *Arenga pinnata* powder. Exceptionally, high amounts of lysine, glutamic acid, aspartic acid and alanine were found in the *Arenga pinnata* powder. Others found in reasonable amounts are methionine, threonine, arginine, serine and glycine. Others found negligible amounts are leusine, isoleusine, valine, proline, thyrosine and hydroxyproline. Similar results were reported by Pätzold and Brückner [13] in maple syrup, palm honey, grape syrup and sugar cane syrup.

4. Conclusions and Recommendations

Data have shown the high levels of polyphenols and presence of antioxidant capabilities from the phenolic contents, antioxidant capacity and free radical scavenging activity measured, sugar content and amino acid. Hence, *Arenga pinnata* juice powder can be reconstituted into a nutritious juice with beneficial bioactive compounds.

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