J. Trop. Agric. and Fd. Sc. 52 (1)(2024): 45 – 50

Chemical composition from different parts of kuini (*Mangifera odorata*) waste

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Abstract

Mangifera odorata is an underutilised fruit found in Malaysia. This fruit has received much interest due to its delicious taste, attractive colour and highly nutritional value. Unfortunately, studies on the benefits of its waste remain scarce and most information are only limited to the nutritional composition or antimicrobial activity per se. The aim of our study was to evaluate the chemical composition in different parts of waste from this fruit. The sugar profile and antinutritional factor composition from its kernel and skin was evaluated via HPLC-ELSD and spectrophotometry method. Analysis of sugar profile revealed that these parts of waste contain considerable amount of fructose, glucose, and sucrose (2.40 to 4.41 mg/100 g in kernel and 3.66 to 6.48 g/100 g in skin). The antinutritional factor content from *M. odorata* waste, namely phytic acid and tannic acid, were in the acceptable range for both part (0.04 – 0.44 mg/100 g in kernel and 0.02 to 0.44 mg/100 g in skin), respectively. These preliminary results were promising and has fortified our confidence in the potential to utilise this inexpensive source as a food ingredient. Still, further work needs to be conducted extensively to maximise the use of this fruits as a premium food ingredient.

Keywords: *chemical composition, sugar profile, antinutritional factors, waste*

Introduction

Malaysia is recognised as a hub blessed with flora and fauna diversity. Based on a conservative estimation by Abdul Shukor et al. 2013, it was suggested that there are currently around 15,000 species of flora in Malaysia and more than 500 species from their suggested numbers are eventually cultivated, underutilised and rare fruits that could be found around Malaysia.

Underutilised fruits in Malaysia are usually related to non-commercial tropical fruits that are planted for local consumption and grown in wild conditions (Khoo et al. 2010). *Mangifera odorata*, commonly known as *kuini* is classified as an underutilised fruit that has the potential to be explored for commercialisation. From a taxonomy point, this plant belongs to the order Sapindales (Anardiacea) which comprises 73 genera and about 830 species and is mainly distributed in tropical countries (Mirfat et al. 2015). Characteristically, this fruit has a striking orange flesh colour as well as a distinctive smell. *Kuini* has an average weight of approximately 325 g; colour turns from green to a canary yellow at maturity; has a rich, sweet flavour and slightly fibrous flesh (Campbell 2007).

During the last decade, interest in *kuini* has been increasing and exploration on the beneficial compound in this fruit were extensively conducted. This fruit has been reported as a good source of antioxidants and others nutritional compound (Mirfat et al. 2015). Research conducted by Adnan et al. 2018 discovered that extracts of fresh and fermented *kuini* could inhibit bacteria that possesses dangerous threat to public health. Their work was considered a pioneer in reporting the antimicrobial activities from extract of this fruit. Samples of their experiment which were fresh and fermented *kuini* showed good antibacterial activities against gram-positive (*Listeria monocytogenes, Listeria innocua, Bacillus cereus, Staphyloccus aureus and Staphyloccus epidermis)* and gram-negative bacteria (*Salmonella enteritidis, Escherichia coli* strains 0157, 1370 and 303*, Pseudomonas aeruginosa* strain PA14 and *Salmonella typhimurium*). They concluded that this finding could add value to the fruits and may probably increase the market demand. More recent evidence from Alyas et al. 2020

Article history
Received: 15.8.23
Accepted: 8.11.23

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revealed that this fruit showed potential characteristic as an alternative to the probiotic substrates for lactic acid bacteria growth. In their study, six different probiotic strains, *L. paracasei* SD5275, *L. acidophilus* DDS- *1, L. plantarum* SD5209*, L. casei* 431*, Bifidobacteria* bb-*12 and L. lactis* exhibited great capability to utilised *kuini* as a substrate without additional nutrient supplement.

Previous work has been limited to profiling of nutritional composition, antioxidant capacities and antimicrobial activities of flesh from this fruit. Detail on the chemical constitution of its waste such as kernel and skin were scarce. Waste from vegetables and fruits are good source of bioactive compounds and include health benefits like dietary fibre (Hussain et al. 2020). Mango peel is reported to have good level of this food component that helps lower risks of cardiovascular disease, obesity, colorectal cancer and coronary heart disease (Rymbai et al. 2013). Many attempts have been made with the purpose to study the bioactive compounds in *kuini* waste. Study done by Lasano et al. 2019 inferred that waste from this fruit contain antidiabetic bioactive compound which is also an excellent source of minerals and macronutrients like protein and carbohydrate. Presence of several compounds such as mangiferin, narigenin and isovitexin was validated by LCMS. Kernel and skin of this fruit have a good level of Vitamin A dan C, dietary fibre, and fatty acid compound i.e. stearic acid and Cis-Oleic acid (Mokhtar et al. 2020).

In spite of various report on beneficial compound in *kuini*, this fruit also contain antinutritional factors that are primarily associated with compounds or substances of natural or synthetic origin, which interferes with the absorption of nutrients and act to reduce nutrient intake, digestion and utilisation and may produce other adverse effects (Popova and Mihaylova 2019). The antinutritional factors in the waste of *kuini* is understudied. Alkaloid, tannin, phytate, cyanide are amongst the common antinutritional factors that could be found in fruit seed including *Mangifera* species (Rymbai et al. 2013). Plant tannin was reported to inhibit the digestibility of protein (Rehman and Shah 2005). Another study also showed that phytic acid acts by blocking the absorption of minerals such as Ca, Fe and Zn (Ertop & Bektaş 2018).

Our knowledge on chemical composition of waste from *kuini* is very limited. The aim of this research was to examine the chemical profiling of its waste from the perspective of sugar profile and antinutritional factors. We conducted this study to accentuate the importance of all the different parts of the *kuini* and to acquire respective profiling of its waste compounds. Information from this research is vital in exploring the fruit waste application in product formation and development.

Materials and method

Preparation of sample

Fresh *kuini* fruit (*Mangifera odorata*) were obtained from MARDI Sintok, Kedah. *Kuini* fruit were washed and processed manually to separate the kernel and skin from the flesh. Both parts were then sliced before being dried at 60 °C till the moisture content of the sample reach 5% using air forced oven, Memmert GmbH, Germany. Samples were then chopped into small pieces and ground into flour prior to analysis.

Determination of sugar profile

Sugar determination was based on method done by Wilson et al. 1981. Sample preparation was initiated by dissolving 250 mg of grind sample with 25 ml distilled water and shake for 30 mins in orbital shaker (Labwit ZHWX-304, Australia). From the mixture, 10 ml of aliquot was removed and mixed 10 ml of methanol, followed by centrifugation at 43 000 rpm for 5 mins (Sigma 2-16K Sartorius Centrifuge, UK). After passing the supernatant through Regenerated Cellulose filter (2µl), sample was collected in vial until further analysis. 5ul samples were injected into HPLC - ELSD (Waters 2996, US). Sugar was separated by a carbohydrate column (Waters Spheriscorb 5µm NH_2 4.0 x 250 mm), using a solvent of Acetonitrile: water (85:15/v:v). The flow rate was maintained at 1.0 ml min^{-1}. Identification and quantification of major sugars present in the samples were achieved by comparing each peak retention time and peak area with those of the standard. Sugar standards were made for glucose, fructose, and sucrose. A standard curve for each sugar was prepared by injecting different concentrations of the solution and plotting HPLC peak areas versus sugar concentrations in the standards.

Determination of antinutrient factors

Determination of tannin

The experimental set up on determination of tannic acid was based on the work done by Azeez,et al. 2015. Dried (finely ground sample, 0.2 g) was soaked in 25 ml of 70% acetone in 25 ml beaker and suspended in an iced ultrasonic water bath (RS Pro Ultrasonic, Malaysia) and subjected to ultrasonic treatment for 20 mins (2 X 10 min with 5 mins break in between). The contents of the beaker were then subjected to centrifugation for 10 mins at approximately 3,000 rpm at 4 °C (Sigma 2-16K Sartorius, UK). The supernatant was filtered using Whatman No 1 filter paper and continue keeping in ice. Three concentration of filtrate was taken, made up to 0.5 ml with distilled water and put on 500 µl of Folin-Ciocalteau reagent. The mixture was then added 0.5ml distilled water and 1.5 ml of Na_2CO_3. It was then vortexed, incubated for 40 mins at room temperature, 20 °C. Absorbance of sample and tannin standards was read against blank at 725 nm. Result was expressed as tannic acid equivalent (mg/100 g).

Determination of phytic acid

Method to determine level of phytic acid was done as described by Latta and Erskin 1980. A 0.5 g of dried sample was weighed into 250 ml conical flask. The initial extraction was done with 2.4% 25 ml HCl, whereas sample was shake in orbital shaker (Labwit ZHWX-304, Australia) for an hour at room temperature and then centrifuge at 3000 rpm for 30 mins (Sigma 2-16K Sartorius, UK). A 3 ml clear supernatant was transferred into test tube for the phytate analysis. A 1 ml of Wade reagent (0.03% solution of $FeCl6H_2O$ containing 0.3% sulfosalicylic acid in water) to the test tube and vortex for a minute. Sample was read at 500 nm absorbance (Microplate Reader EON, Biotek, UK) and phytate was quantified from a standard calibration curve of phytic acid (2 to 10 mg/ml). Result was expressed as phytic acid, g/100 g.

Statistical analysis

All data collected were expressed in triplicate and reported as mean ± SD (standard deviation). Statistical analyses were performed using Statistical Analysis Software (SAS) package (version 9.1.4 of SAS Institute, Inc. Cary, NC, 2008). Means were determined by One Way Analysis of Variance (ANOVA) then compared using the Duncan Multiple Range Test (DMRT) to determine the significances. Effects were considered significant at $p > 0.05$.

Result and discussion

Sugar profile of the kuini kernel and skin.

Mango waste was reported to contain high sugar content which is around 13.2%. It was palatable and a good source of energy but due to high moisture content, it was prone to damage in short time (Wadhwa & Bakshi 2013). *Figure 1* (a, b and c) shown the calibration curve of sugars and *Figure 2* and *3* illustrated the chromatogram of sugar in kernel and skin.

From the results showed in *Figure 4*, sucrose was predominant sugar for both waste parts (4.41 g/100 g in kernel and 6.474 g/100 g in skin) respectively. There were also presence of fructose and glucose in kernel and skin. Sucrose, fructose and glucose were also reported in studies done by Bello-Pérez et al. 2007 and Lasano et al. 2019. Level of sugar in mango variety Cameroon determined by Bello-Pérez et al. 2007 were 4.7, 8.1 and 0.8 g/100 g for sucrose, fructose and glucose, respectively. Sugar content in Lasano et al. 2019 were in the range of 0.83 to 2.66 g/100 in skin and 0.98 to 2.66 g/100 g in kernel. While not detected level was reported for the kernel, total sugar in experiment conducted by Lebaka et al. 2021 was relatively higher in mango skin which is 25 g/100 g. The variation in the level of sugar between studies was probably due to the maturity factor of the fruits during harvest. During the ripening process, starch is converted to fructose and glucose hence level of sugar increased (Bello-Pérez et al. 2007).

Antinutrient factors in kuini kernel and skin

Antinutrient factors are group of chemical compound present naturally in plant that decreased the availability of nutrients (Ram et al. 2020). *Table 1* demonstrate antinutritional factor in both parts of the waste. On average, phytic acid and tannic were present at low level in both samples (0.02 – 0.04 mg/100 g and 0.34 – 0.44 mg/100 g respectively). Higher level of phytic acid and tannin in kernel sample was reported at 1.44 and 1.03 mg/100 g, respectively by Fowomola 2012. This trend was also similar with experiment conducted by Runyogote et al 2020. Phytic acid was determined at 2.91 mg/100 g and tannin was reported at 0.49 mg/100 g.

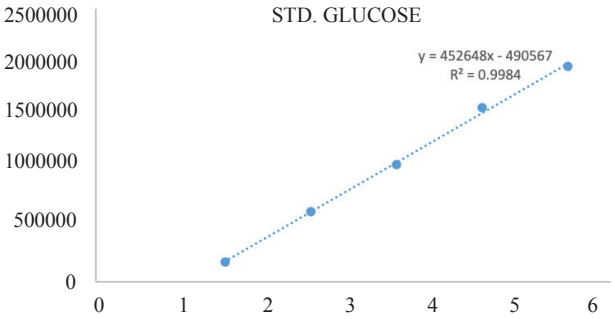

Figure 1 (a). Graph of calibration curve glucose standard

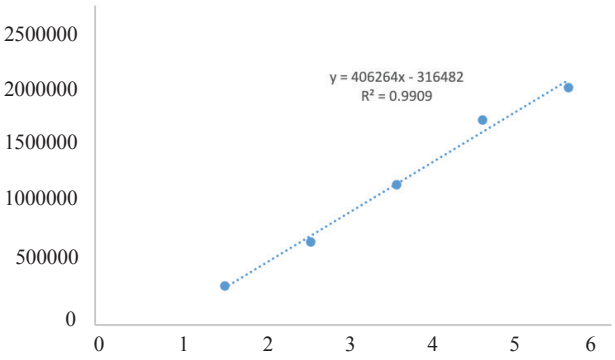

Figure 1(b). Graph of calibration curve standard fructose

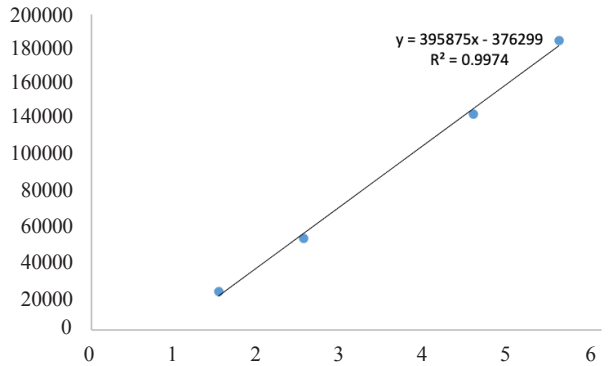

Figure 1 (c). Graph of calibration curve sucrose standard

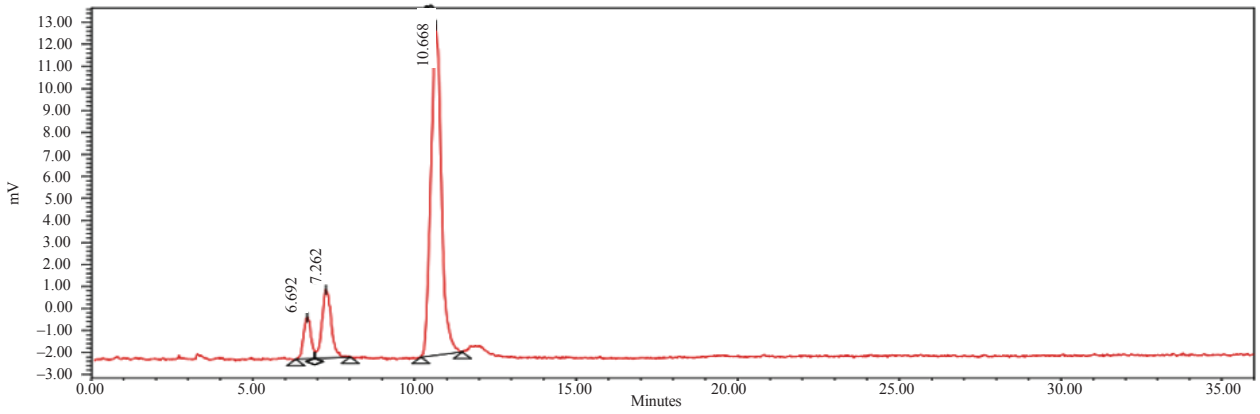

Figure 2. Chromatogram of sugar profile in kuini kernel

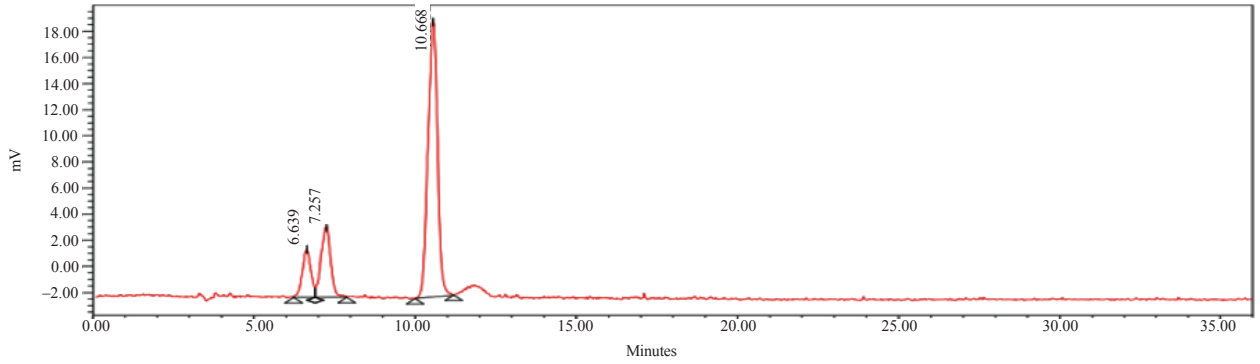

Figure 3. Chromatogram of sugar profile in kuini skin

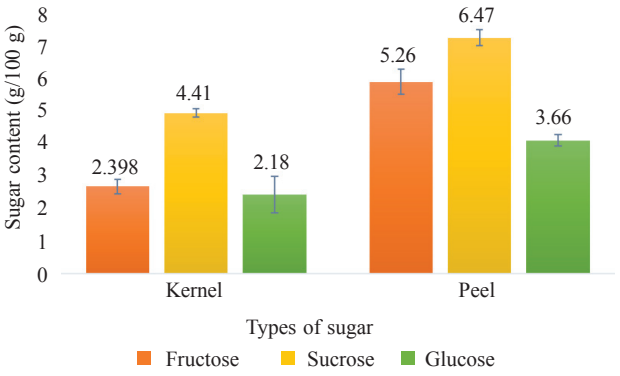

Figure 4. Bar chart of sugar content from kuini kernel and skin

Both experiment confirmed the existence of these two undesirable compounds in kuini wastes which complexes essential nutrients thus decreasing their bioavailability (Fowomola 2010).

Besides having a good level of sugar content and acceptable level of antinutrients, these two parts of *kuini* waste also contain satisfactory level of macro and micronutrients. Our previous research illustrated in *Table 2* below reveal the nutrition composition of *kuini* waste. The overall value exhibited that waste from this fruit has the potential to be explored as high quality food ingredients.

Table 1. Antinutritional factor in *kuini* kernel and skin (mg/100 g)

Sample	Phytic acid	Tannic
Kernel	0.04 ± 0.01[a]	0.44 ± 0.08[a]
Skin	0.02 ± 0.01[b]	0.34 ± 0.01[b]

Data was expressed as mean ± SD, each value is a mean of triplicate reading (n = 3)
Means within column with different letter are significantly different at (p = 0.05)

Table 2. The nutritional composition in *kuini* kernel and skin

Samples	Kernel	Skin
Moisture, g/100 g	3.77 ± 0.37	7.39 ± β0.10
Ash, g/100 g	2.89 ± 0.11	5.87 ± 0.18
Protein, g/100 g	5.17 ± 0.02	4.07 ± 0.02
Fat, g/100 g	7.97 ± 0.35	1.06 ± 0.30
Dietary fibre, g/100 g	13.52 ± 1.33	58.47 ± 2.37
Energy value, kcal/100 g	428.14 ± 2.84	381.71 ± 0.71

Data was expressed as mean ± SD, each value is a mean of triplicate reading (n = 3)
Source: Mokhtar et al. 2020

From the experiment, it demonstrated that samples had good level of dietary fibre from both parts. High dietary fibre materials from fruits or its peel have been steadily introduced in the occidental world market (Bello-Pérez et al. 2007). Dietary fibre from our sample (58.47 g/100 g) was higher compared to those reported by Vergara-Valencia et al. 2007 (28.1 g/100 g). This finding was similar with Lebaka et al. 2021 where the dietary fibre for skin was in the range of 40 – 75 g/100 g. It has now been demonstrated that fruit dietary fibre have better nutritional quality than those from another sources, because of their significant contents of associated bioactive compounds such as flavonoids, carotenoids, etc (Vergara-Valencia et al. 2007). This finding again proved the potential of waste from this fruit to be utilised as food ingredients. The fat content of our sample for both parts (7.97 g/100 g for kernel and 1.0 g/100 g for skin) appeared to be lower than reported by Lebaka et al. 2021(9.4 g/100 g for kernel and 2.2 g/100 g for skin). Lipid and fat were high demand in food industry due to the distinguished effect in functional properties (Torres-León et al. 2016). Mango kernel has been re-evaluated because its fat had shown significant functional and physicochemical characteristics that could lead to it replacing cocoa butter (Solís-Fuentes and del Carmen Durán-de-Bazúa, 2011). This results offer vital evidence of the importance to utilise this waste from kuini plants.

Conclusion

From this study, it was discovered that both parts of *kuini* waste demonstrated good range of sugar, that could be exploited as a natural sweetener. The presence of antinutritional factors in our samples were consistently within the good and acceptable range (0.02 – 0.04 mg/100 g and 0.34 – 0.44 mg/100 g for phytic acid and tannin, respectively). The nutritional composition of these parts also recorded satisfactory level of dietary fibre (13.52 – 58.47 g/100 g). With proper technique, this could be a promising source of prebiotic ingredients. The information presented in this experiment extend and support the previous knowledge that *kuini* (*Mangifera odorata*) wastes are good sources of beneficial compound. This could serve as a guideline to further process, extract or develop value added products from this waste. Extensive study needs to carried out to maximise the usage of these inexpensive raw materials in food industry.

Acknowledgement

The author acknowledges with gratitude the sponsorship from MARDI, Ministry of Agriculture and Agro-based Industries (now known as Ministry of Agriculture and Food Security, KPKM) and Dr. Hadijah Hassan, the Deputy Director of Food Science and Technology, MARDI for all the support along the study. The author would also like to acknowledge with much appreciation the crucial rule of all the supporting staff especially Ms. Aida Mohamad, Ms. Nor Fadhilah Sapie and Mr. Hasri Halim for the technical support in this project. Special thanks to Mr. Saiful Zaimi for the irreplaceable support and constructive comments in the preparation of this manuscript.

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