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NUTRITIONAL COMPOSITION OF UNRIPE AND RIPE FREEZE-DRIED TERUNG ASAM FROM SARAWAK

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ABSTRACT

This study aimed to assess and compare the nutritional composition between unripe and ripe freeze-dried Terung Asam from Sarawak. Terung Asam was checked for its maturity upon collection. Whole fruits were freeze-dried and used for proximate analyses. The redness/greeness (a*) of unripe and ripe fresh Terung Asam used in this study were -14.20 ± 3.11 and 12.57 ± 1.60 respectively. The moisture content of unripe fresh Terung Asam was significantly higher than ripe fresh Terung Asam ($p < 0.05$). There were statistically significant differences in crude protein ($p < 0.05$), crude fat ($p < 0.05$), ash ($p < 0.05$) and crude fibre ($p < 0.001$) between unripe and ripe freeze-dried Terung Asam (UFTA and RFTA respectively). RFTA had higher crude fibre (19.87 ± 0.68g/100g) and ash (6.20 ± 0.18g/100g) than UFTA (13.86 ± 0.58g/100g crude fibre, 5.43 ± 0.12g/100g ash). In contrast, UFTA was higher in protein (10.77 ± 0.30g/100g) and fat (0.74 ± 0.05g/100g) than RFTA (9.43 ± 0.40g/100g crude protein, 0.48 ± 0.08g/100g fat). The results of this study suggested that whole fruits of UFTA and RFTA were good source of crude protein, crude fibre and mineral. The data gathered from this research can contribute to the body of knowledge of this underutilized indigenous fruit as well as becoming useful for future product development using Terung Asam.

Keywords: Terung Asam / Terung Dayak; *Solanum lasiocarpum Dunal*; unripe; ripe; freeze dried, nutritional composition.

INTRODTUCION

Terung Asam, also known as Terung Dayak (*Solanum lasiocarpum Dunal*), a species of the Solanaceae family, is a native eggplant in Sarawak, It is also one of the Geographical Indications (GI) products of Sarawak. The perennial plant is thorny and woody, grows to a height of approximately 1.0 to 2.5 metres. It produces medium-sized, round to oval and sour fruits. Immature fruit is green and turns yellow to orange when it is ripe. Some have tints of dark purple. It is commonly used as vegetable by local communities. The fruit can be easily found at local markets and it is widely used as an ingredient or flavouring in many local dishes due to its sour taste (Umah 2012). Furthermore, the Dayak people use it as traditional medicine believing that Terung Asam can cure pinworms infection (AsianItinerary 2013). According to Voon and Kueh (1999), Terung Asam has received great attention due to its nutritional value. Researchers at the Department of Agriculture Sarawak have developed the Terung Asam into several products such as jam, puree, juice and dehydrated slices (Dayod and Lim 2015).

Freeze-drying is a process whereby water in food material is removed by sublimination. Controlled freeze drying keeps the material's temperature low enough during the process to avoid

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changes in the appearance and characteristics of the dried material. It is also the recommended drying method for material which contains heat-sensitive antioxidant components, such as plant phenolic, carotenoids, ascorbic acid and tocopherols (Marques et al. 2009). Nevertheless, some studies showed that freeze drying did affect the composition of some antioxidants and the antioxidant activity in the fruits (Chang et al. 2006; Shofian et al. 2011).

To date, few studies were conducted on Terung Asam. However, the studies are more focused on the flesh of ripe fruit. Exploration of usefulness of unripe and ripe whole fruit can widen the scope of fruit consumption and its prospective application. Therefore, this study aimed to investigate and compare the nutritional composition between unripe and ripe freeze-dried Terung Asam (UFTA and RFTA).

RESEARCH METHODOLOGY

Sample Preparation and Chemicals

Both unripe and ripe Terung Asam without physical damages were purchased from Sibu Central Market, Sarawak and checked for maturity using chromameter. The whole fruits of Terung Asam were then washed under tap water to remove soils and cut into small cubes using a vegetable cutter. pH was measured by pH meter (H160, Hach, USA) before the cubes were dried in freeze dryer (AdVantage Pro, VirTis SP Scientific). After freeze drying, the samples were blended into fine powder and stored at -20°C for further analysis. All other chemicals used in the study were of analytical grade.

Colour Measurement

Colour measurement was carried out using chromameter (CR-400, Konica Minolta, Japan). Results were recorded as L*, a*, and b* values, where L* describes lightness (0, black; 100, white), a* indicates redness (- green; + red), and b* indicates yellowness (- blue; + yellow). Three measurements were made at different surfaces of the sample and results were averaged.

Proximate Analysis

The moisture, ash, fat, protein and crude fibre of the sample were determined on dry weight basis according to AOAC (2016). The moisture content of the fresh and dried samples was determined by using oven-drying method. The Soxtec equipment was used to extract and determine the crude fat in samples. Protein in the sample was determined by using Kjeldahl method and factor of conversion used was 6.25. Crude fibre was determined by sequential extraction with boiling 0.1275M of sulphuric acid and 0.313M of sodium hydroxide. Carbohydrates were calculated by percentage difference. Water activity (a_w) was measured using Sartorius Moisture Analyser (Model MA150, Goettingen, Germany). All samples were analysed in triplicates.

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Statistical Analysis

IBM SPSS version 23.0 (Armonk, New York) was used for data analysis. Data were reported as mean ± standard deviation, where $n = 3$. Independent t-test was used to compare the means of proximate nutrient composition between unripe and ripe fruit samples. Difference at p value < 0.05 was considered statistically significant and p value < 0.001 was considered very statistically significant.

RESULTS AND DISCUSSION

General Composition of Unripe and Ripe Fresh Terung Asam

The greenness (-a*) of unripe fresh Terung Asam used in this study was -14.20 ± 3.11 whereas the redness (a*) of ripe fresh Terung Asam was 12.57 ± 1.60. The ripe Terung Asam was darker and more yellowish than unripe Terung Asam (Table 1).

The moisture content of unripe Terung Asam was 89.83 ± 1.12% which was significantly higher than ripe Terung Asam, 88.05 ± 1.08% ($p < 0.05$). Few studies have shown decreasing of moisture content in fruits during the ripening period and this is due to the evaporation of moisture from the surface of the fruits (Inyang and Agbo, 1995; Othman and Mbogo, 2009; Hellen et al, 2014). Furthermore, unripe Terung Asam was significantly less acidic than ripe Terung Asam ($p < 0.05$). The distinctive sour taste of the fruit makes it favourable for the locals to use it as flavouring in many dishes, particularly the ripe fruit (Umar, 2012).

Table 1: Maturity Status, Moisture Content and Ph Of Unripe and Ripe Fresh Terung Asam

Parameter	Fresh Terung Asam	
	Unripe	Ripe
L* (lightness)	48.83 ± 2.82	74.39 ± 1.33
a* (redness)	-14.20 ± 3.11	12.57 ± 1.60
b* (yellowness)	31.44 ± 2.23	70.52 ± 1.68
[α]Moisture content (%)	89.83 ± 1.12	88.05 ± 1.08
[α]pH	5.06 ± 0.21	4.70 ± 0.12

[α]p <0.05. Each value is the average of triplicate measurement.

Nutrient Composition of Unripe and Ripe Freeze-Dried Terung Asam

The results in Table 2 indicated that there were statistically significant differences in crude protein ($p < 0.05$), crude fat ($p < 0.05$), ash ($p < 0.05$) and crude fibre ($p < 0.001$) between unripe and ripe freeze-dried Terung Asam (UFTA and RFTA). RFTA had higher crude fibre (19.87 ± 0.68g/100g) and ash (6.20 ± 0.18g/100g) than UFTA. In contrast, UFTA contained higher protein (10.77 ± 0.30g/100g) and fat (0.74 ± 0.05g/100g) than RFTA.

A comparative look at the nutrient composition studies of Terung Asam, mostly on the flesh of ripe fruit reported by other researchers was also presented in Table 2. The crude protein, crude fibre and ash of freeze-dried Terung Asam for both unripe and ripe fruit were relative higher

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than oven dried (0.34g/100g crude protein, 5.59g/100g crude fibre, 0.45g/100g ash) and fresh Terung Asam (1.10 g/100g crude protein, 1.70g/100g crude fibre, 0.80g/100g ash). This could be due to whole fruit of Terung Asam was being used in this study, including the seed and skin, other than flesh. According to El-Safy et al. (2012), watermelon seed (30.11%), apple seed (33.79%) and pawpaw seed (31.26%) were high in protein content. In addition, Al-Wandawi et al. (1985) showed that tomato skin and seeds contained some essential amino acids and the tomato seeds had higher minerals. The ash content is a measure of the total amount of mineral present within a food and a high total ash content in food means the presence of adulterants (Al-Maiman et al. 2001). Skin and seed of Terung Asam were the factors that contributed to higher ash and crude fibre in this study. Whole fruit of Terung Asam could be suggested as a good source of protein, fibre and mineral.

The crude fat of UFTA and RFTA obtained in this study were 0.74 ± 0.05g/100g and 0.48 ± 0.08g/100g which were less than 1g/100g. Razili et al. (2015) had reported nil crude fat of ripe, oven-dried Terung Asam. Therefore, Terung Asam would potentially fit into any low fat diet. In general, fruits which have low levels of fat are not good source of energy. Thus, they can be recommended for weight management diet (Hellen et al. 2014).

Freeze-dried Terung Asam had the lowest moisture content compared to the oven dried (10.54g/100g) and fresh Terung Asam (89.48g/100g). Based on this, the freeze-dried fruits could be kept for long-term storage as they were stable and less susceptible to microbial deterioration. Marques et al. (2009) stated that freeze drying can extend the shelf life of fruits by preventing the microbial growth. Furthermore, high moisture content would decrease the energy value as it reduces the proximate principles such as fat, protein and carbohydrate (Mitchel et al., 1976).

Table 2: Comparison of Nutrient Composition of Unripe and Ripe Freeze-Dried Terung Asam Sarawak with Previous Studies.

Composition (per 100g)	Current study		Razili et al. 2015	Voon and Kueh, 2012
	Unripe, freeze-dried whole fruit	**Ripe, freeze-dried whole fruit**	**Ripe, oven dried flesh**	**Ripe, fresh flesh**
Total Carbohydrate (g)	64.05	59.30	81.67	5.80
Crude protein (g)	10.77 ± 0.30 [a]	9.43 ± 0.40 [a]	0.34	1.10
Crude fat (g)	0.74 ± 0.05 [a]	0.48 ± 0.08 [a]	0.00	0.90
Crude fibre (g)	13.86 ± 0.58 [b]	19.87 ± 0.68 [b]	5.59	1.70
Ash (g)	5.43 ± 0.12 [a]	6.20 ± 0.18 [a]	0.45	0.80
Moisture content (g)	5.15 ± 0.64	4.72 ± 1.05	10.54	89.48

Data from current study was presented as mean ± standard deviation of triplicate measurement. Means followed by different letters within a row are significantly different at [a]p <0.05, [b]p <0.001.

CONCLUSION

The present study revealed that there were significant differences in the content of crude protein, crude fat, crude fibre and ash between UFTA and RFTA. The crude fibre and ash were higher in RFTA while crude protein and crude fat were higher in UFTA. Overall, whole fruit of freeze-dried

Terung Asam is a good source of crude protein, crude fibre, mineral and low in crude fat. The data gathered could contribute to the body of knowledge of this underutilized indigenous fruit as well as useful for future product development of Terung Asam. Analysis according to fruit part (seed, flesh and skin) of Terung Asam is recommended for future research.

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