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Proximate composition and selected mineral determination in organically grown red pitaya (*Hylocereus* sp.)

[Penentuan komposisi proksimat dan mineral terpilih dalam buah pitaya merah (*Hylocereus* sp.) yang ditanam secara organik]

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Key words: proximate analysis, minerals, red pitaya

Abstract

Hylocereus species has generated a lot of interest as a source of natural red colour for food colouring, cosmetic industry and health potential for improving eyesight and preventing hypertension and combating anaemia. This study was conducted to determine the proximate composition, carbohydrate, crude fibres and minerals content in red pitaya fruits (*Hylocereus* sp.) which were obtained from organically grown plantation.

Results showed that the red pitaya proximate composition were 87.30% moisture, 0.70 g ash, 0.16 g protein, 0.23 g fat, 10.10 g crude fibre and 1.48 g carbohydrate. The mineral content in red pitaya was calcium (5.70 mg), phosphorus (23.0 mg), magnesium (28.30 mg), sodium (50.15 mg), potassium (56.96 mg), iron (3.40 mg), zinc (13.87 mg) and copper (0.031 mg). The results showed that red pitaya fruits could have potential health benefits in preventing risk factors of certain diseases such as cardiovascular disease, diabetes mellitus, preventing hypertension and hypercholesterolemia, preventing anaemia and improving eyesight.

Introduction

Fruits and vegetables contain significant levels of biologically active components beneficial to health beyond basic nutrition (Oomah and Mazza 2000). They are also an important source of essential elements (Tahvonen 1993), proximate composition and minerals which play vital role in the proper development and good health of the human body. Fruit is considered to be the main source of minerals needed in the human diet (Chauhan et al. 1991).

Minerals in fruit are some of the important nutrients besides vitamins, flavonoids and phytochemicals which have been reported to contribute to health. The importance of optimal intake of essential mineral elements to maintain peak health is widely recognised. Inadequate intake of mineral elements has been observed to be a

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major nutritional problem in our environment. Minerals have many essential roles, both as ions dissolved in body fluids and as constituents of essential molecules. Minerals such as magnesium and zinc had significantly increased HDL-C apo-A1 in type 2 diabetic patients. Supplementation of minerals could be recommended for type 2 diabetic patients based on their daily requirement (Chauhan et al. 1991).

Hylocereus sp. belongs to the cacti family from the subfamily Cactoidea of the tribe Cactea (Raveh et al. 1993). This tribe consists of many species with edible fruits and mostly known as pitaya. The common name pitaya is because of the scales on the skin which means 'the scaly fruits' (Cai et al. 2003). This plant is currently grown commercially in Taiwan, Vietnam and Malaysia.

In Malaysia, pitaya is known as dragon fruit. Currently there is no study published on the proximate and mineral composition of red pitaya organically grown from local plantations. Therefore, this study was carried out to determine the proximate composition and selected mineral content in organically grown red pitaya (*Hylocereus* sp.).

Materials and methods

Fruit

Red pitaya fruit (*Hylocereus* sp.) used in this study was obtained locally from Nutri-Red Plantation Sdn. Bhd. The plants were grown organically in Kerdau Plantation, Kuala Pilah, Negeri Sembilan, Malaysia.

Sample preparation

Upon arrival at Department of Nutrition and Dietetic laboratory, the red pitaya fruit was immediately cleaned by washing under running tap water to remove soil, and drained off before used. The edible portion i.e. the flesh of red pitaya fruit (100 g) was cut into small pieces and homogenized using blender (National MX-T3GM, Taiwan) for 2 min. The homogenized sample was transferred into air tight container and kept at –80 °C for 2 days before freeze-drying at –45 °C, pressure 12 militor for 3 days using freeze dryer (BEWHAY/SB4, United Kingdom). The freeze-dried sample was kept at –20 °C before further analysis. All procedures were carefully carried out with minimum exposure to light. All the chemicals and reagents used were of analytical grades or as otherwise stated.

Proximate composition analysis

Moisture, total ash, fat and protein content in the sample were determined using method by AOAC (1984) and Tee et al. (1996). The total ash content was determined by heating 8–10 g of the dried sample in a silica dish at 130 °C for 24 h in oven (Memmert 600, Germany). After 24 h, the dish was placed in cold muffle oven (Furnace 5500, Germany) at 550 °C for 8 h.

The micro-Kjeldahl machine (Tecator Kjeltec System 1002, Sweden) and method was used to determine nitrogen. The percentages of nitrogen were converted to protein by multiplying by 6.25. The fat content was determined by directly extracting the dried ground pitaya fruit with petroleum ether in an intermittent extraction apparatus of the Soxhlet type. The residue in the extraction flask after solvent removal represents the fat content of the sample.

Carbohydrate and crude fibre determination

The total carbohydrate and crude fibre in red pitaya fruit was determined using the method introduced by the AOAC (1984). The change of colour was determined using a spectrophotometer (Secomam, France).

Mineral determination

Calcium, phosphorus, magnesium, sodium, potassium, iron, zinc and copper content of the red pitaya were determined from the ash solution of red pitaya samples using the flame system of the Atomic Absorption Spectrophotometer (GBC, Model #908AA, USA).

Data analysis

All data were expressed as mean ± SD. The determinations were carried out in 12 triplicates.

Results

Proximate composition

Expressed in fresh matter basis (100 g), the moisture content formed the bulk of tissue weight in the fresh red pitaya flesh with the mean value 87.3% *(Table 1)*. The total ash mean value was 0.7 g and it showed that the fruit contained some minerals which could be useful in improving health. The mean values for protein and fat were 0.16 g and 0.23 g per 100 g of fresh edible portion basis.

The mean values of carbohydrate composition and crude fibre in this fruit were 1.48 g and 10.1 g in 100 g of fresh edible portion basis respectively *(Table 2)*. The moisture content was 87.3%, which was higher than fruit from Taiwan (83.0%). The fruit has higher values for moisture and ash but lower values for protein and fat as compared to the red pitaya from Taiwan.

Comparison of mean values for proximate composition between red pitaya and other local fruits such as guava, papaya and pineapples is shown in *Table 2*. The

Table 1. Proximate composition of red pitaya fruit from organically grown farm in Malaysia (100 g of edible portion)

Sample	Moisture (%)	Ash (g)	Fat (g)	Protein (g)	Carbohydrate (g)	Crude fibre (g)
1	87.30 ± 0.015	0.70 ± 0.20	0.23 ± 0.025	0.16 ± 0.015	1.48 ± 0.35	10.10 ± 0.25
2	87.40 ± 0.01	0.71 ± 0.10	0.24 ± 0.015	0.16 ± 0.01	1.47 ± 0.31	10.20 ± 0.32
3	86.90 ± 0.05	0.69 ± 0.20	0.22 ± 0.02	0.17 ± 0.015	1.49 ± 0.32	10.00 ± 0.23
4	87.30 ± 0.15	0.70 ± 0.25	0.21 ± 0.025	0.15 ± 0.04	1.48 ± 0.05	10.50 ± 0.25
5	87.30 ± 0.25	0.68 ± 0.20	0.26 ± 0.01	0.18 ± 0.23	1.47 ± 0.15	9.70 ± 0.26
6	87.40 ± 0.15	0.72 ± 0.05	0.27 ± 0.025	0.14 ± 0.07	1.49 ± 0.25	10.10 ± 0.29
7	87.50 ± 0.02	0.73 ± 0.20	0.19 ± 0.67	0.13 ± 0.76	1.48 ± 0.25	10.10 ± 0.32
8	87.30 ± 0.15	0.67 ± 0.25	0.20 ± 0.025	0.19 ± 0.03	1.48 ± 0.15	10.00 ± 0.30
9	87.60 ± 0.05	0.71 ± 0.22	0.26 ± 0.05	0.16 ± 0.23	1.50 ± 0.45	10.20 ± 0.32
10	87.60 ± 0.51	0.69 ± 0.12	0.27 ± 0.02	0.16 ± 0.03	1.46 ± 0.65	10.10 ± 0.31
11	87.40 ± 0.03	0.70 ± 0.34	0.23 ± 0.025	0.16 ± 0.50	1.48 ± 0.39	10.10 ± 0.02
12	86.98 ± 0.10	0.70 ± 0.27	0.23 ± 0.025	0.16 ± 0.02	1.48 ± 0.35	10.10 ± 0.32
Mean	87.30 ± 0.015	0.70 ± 0.20	0.23 ± 0.025	0.16 ± 0.015	1.48 ± 0.35	10.10 ± 0.25

Data was expressed as mean ± SD, each value is a mean of triplicate reading

Table 2. Comparison of proximate analysis of red pitaya, guava, papaya and pineapple in Malaysia (100 g of edible portion)

Sample	Moisture (%)	Ash (g)	Fat (g)	Protein (g)	Carbohydrate (g)	Crude fibre (g)
Red pitaya (Malaysia)*	87.30 ± 0.02b	0.70 ± 0.20a	0.23 ± 0.03a	0.16 ± 0.02a	1.48 ± 0.35a	10.1 ± 0.25a
Red pitaya (Taiwan)[3]	83.00a	0.28c	0.61c	0.229a	Na	0.90c
Guava [1]	81.57a	0.45b	0.20a	1.10c	10.00c	6.80b
Papaya [2]	90.70c	0.47b	0.10b	1.50c	7.10b	0.50d
Pineapple [2]	87.80b	0.62a	0.10b	0.50b	10.60c	0.60d

*Data was expressed as mean ± SD, each value is a mean of triplicate reading
Means with the same letter at any column are not significantly different (p <0.05)
Na = Data is not available
Source: [1]Fadhilah (2002); [2]Tee et al. (1997); [3]TFIDRA (2000)

moisture content in red pitaya was significantly higher than in guava, but lower than in papaya and pineapple. Local red pitaya contained more ash than fruit from Taiwan (0.28 g). The local red pitaya also contained more ash than guava, papaya and pineapple.

The protein value for red pitaya was significantly lower than guava, papaya and pineapple. Red pitaya contained more fat than guava, papaya and pineapple but lower when compared to red pitaya from Taiwan. Carbohydrate content in red pitaya was lower than in guava, papaya and pineapple. There was significantly (p <0.05) higher crude fibre content in red pitaya than in guava, papaya and pineapple.

Mineral composition

Macroelements The macroelements in red pitaya were calcium (5.7 mg), phosphorus (23.0 mg), magnesium (28.3 mg), sodium (50.2 mg) and potassium (56.9 mg) *(Table 3).* The high level of sodium concentration in this fruit was probably due to the organic fertilizer and mineral content in the plantation soil. The plantation was located relatively on the high ground (small hill) near a fresh water source.

The sodium value in red pitaya was higher compared to guava, and significantly higher than papaya and pineapple *(Table 3)*. The value of potassium was also significantly higher in red pitaya when compared to guava, papaya and pineapple. Whereas, calcium content in red pitaya was significantly lower than guava, papaya and pineapple. Red pitaya also contained significantly higher magnesium and phosphorus compared to guava, papaya and pineapple.

Microelements The microelements in red pitaya were iron (3.40 mg), zinc (13.87 mg) and copper (0.03 mg) *(Table 3).* Comparison with other local fruits (guava, papaya and pineapples) showed that the iron content in red pitaya was higher. The zinc content in red pitaya was significantly higher than in the three fruits. Whereas, mineral copper content in red pitaya was significantly lower than in guava, papaya and pineapple.

Discussion

Many epidemiological studies show negative correlations between the intake of vegetables and fruits and the incidence of several important diseases, including cancer and atherosclerosis (Kris-Etherton et al. 2002; Gundgaard et al. 2003; Maynard et al. 2003; Trichopoulou et al. 2003). Vegetables and fruits are known to contain components with several types of health promoting actions [as vitamins, essential minerals, antioxidants

Table 3. Comparison of mineral analysis of red pitaya with guava, papaya and pineapple in Malaysia (100 g of edible portion)

Elements	Red pitaya (Malaysia)*	Red pitaya (Taiwan)[3]	Guava[1]	Papaya[2]	Pineapple[2]
Calcium (mg)	5.70 ± 0.08b	6.3b	22.59a	10.08a	29.93a
Phosphorus (mg)	23.00 ± 0.04a	30.20b	15.00c	7.00d	6.00d
Magnesium (mg)	28.30 ± 0.97a	Na	2.13d	9.75c	11.58b
Sodium (mg)	50.15 ± 0.10a	Na	44.08b	3.48c	36.5c
Potassium (mg)	56.96 ± 0.02a	Na	15.40b	14.61b	15.77b
Iron (mg)	3.40 ± 0.25a	0.55b	1.20c	0.58b	2.49a
Zinc (mg)	13.87 ± 0.68a	Na	1.78b	1.28b	2.44c
Copper (mg)	0.03 ± 0.04a	Na	1.64b	0.95c	1.32b

*Data was expressed as mean ± SD, each value is a mean of triplicate reading
Means with the same letter at any column are not significantly different (p <0.05)
Na = Data is not available
Source: [1]Fadhilah (2002); [2]Tee et al. (1997); [3]TFIDRA (2000)

and pre-biotics (fibres)]. Besides providing vitamins and minerals to the diet, fruit is also utilized for their medicinal purposes because of the presence of other active compounds such as phytochemical and flavonoids. These compounds were found to have some health benefits in reducing the risk factors of chronic diseases.

From the results, red pitaya was shown to have high crude fibre and mineral content, especially potassium, sodium, magnesium, phosphorus, zinc and iron. An earlier report by Santoso et al. (1996) indicated that high amount of the potassium is present as potassium silicate. High levels of ash were also found in this study compared with the previous study by TFIDRA (2000). This study also showed that red pitaya contained high iron when compared with other fruits like guava, papaya and pineapple. Therefore from this result it could be suggested that red pitaya can be used as a diet therapy to prevent anaemia.

The calcium content in this fruit could supplement calcium to the body to prevent hypocalcaemia, which from the previous study showed that patient with heart failure demonstrates increased bone mineral turnover and higher incidence of osteoporosis (Chauhan et al. 1991). The high content of magnesium in this fruit will be useful in replacing magnesium in the body which is lost naturally due to the digestion and absorption from small intestine and excreted in the urine. Magnesium deficiency is associated with an increase rate of ventricular ectopic beats, both in the presence of left ventricular dysfunction (Coudray et al. 1993) and normal cardiac function. Zinc is a powerful site-specific antioxidant. Deficiency of zinc leads to elevated oxidative stress and cholesterol level in rats. A combination of zinc deficiency and ethanol can lead to contractile dysfunction in pre-ischemic conditions in the rat model (Coudray et al. 1993). Copper is also a powerful antioxidant and involved in the acute phase reaction. As such it involved in the regulation of oxidative free radicals and deficiency increases lipoprotein peroxidation (Rayssiguier et al. 1993). Copper deficiency in humans is associated with elevated cholesterol levels (Klevay and Rudel 1984; Klevay 1987).

A diet rich in fruits and vegetables offers the possibility of health benefits beyond that of a protective role against cancer. Large-scale adoption of a diet rich in fruits, vegetables, and low-fat dairy products combined with reduced intake of saturated and total fat, is estimated to reduce coronary heart disease by approximately 15% and stroke by approximately 27% (Appel et al. 1997). A diet rich in fruits and vegetables may be a low-cost and practical means to delay cataracts (Taylor et al. 1995), may help to prevent asthma and bronchitis, particularly among children (Klerk et al. 1992), and may provide an additional approach for the prevention and treatment of hypertension (Appel et al. 1997).

Conclusion

Although fruits and vegetables are a major dietary source of vitamins and fibre, and many observational studies in humans suggest that ample consumption of fruits and vegetables may prevent cardiovascular disease (Ness and Powles 1997) and cancer (Steinmetz and Potter 1996), however mean consumption of these foods is still below the intake levels recommended by public health authorities [3–5 servings of vegetables and fruit according to the guidelines of Nutrition Society of Malaysia (NSM 2003)]. Many people seem not to be aware that their fruits and vegetables consumption is below the recommended level (Lechner et al. 1997).

This study has provided a structured approach for selection of nutrients from local red pitaya, which is likely to have an important impact on health, and there are good prospects that this knowledge will lead to food with improved nutritional quality and health. The approach described here can primarily be used to identify nutrients

responsible for health promoting properties, and thus allow targeted improvement of the composition of the food, and may also lead to the discovery of compounds with therapeutic potential in local red pitaya fruit.

Improved knowledge of which component and concentrations in food are beneficial for health will be crucial for future systematic efforts to improve food quality. From this study, it can be concluded that red pitaya fruit was a very nutritious fruit with higher content in fibre and minerals. Therefore, red pitaya could help in the growth development and has potential health benefits in reducing the risk of chronic disease such as hypertension, hypercholesterolemia, diabetes mellitus, cardiovascular disease and prevent anaemia.

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Abstrak

Spesies *Hylocereus* telah memainkan peranan yang penting sebagai sumber warna merah semula jadi bagi pewarna makanan, industri farmaseutikal dan potensi kesihatan bagi meningkatkan tahap penglihatan, mencegah hipertensi dan melawan anemia. Kajian ini dilakukan bagi menentukan kandungan komposisi proksimat, karbohidrat, fiber kasar dan mineral dalam buah pitaya merah (*Hylocereus* sp.) yang diperoleh dari ladang yang mengamalkan pertanian secara organik.

Keputusan komposisi proksimat yang diperoleh menunjukkan buah pitaya merah mempunyai 87.3% lembapan, 0.7 g abu, 0.16 g protein, 0.23 g lemak, 10.1 g fiber kasar dan 1.48 g karbohidrat. Hasil penentuan kandungan mineral di dalam buah pitaya merah ialah kalsium (5.7 mg), fosforus (23.0 mg), magnesium (28.3 mg), natrium (50.2 mg), kalium (56.9 mg), ferum (3.4 mg), zink (13.8 mg) dan kuprum (0.031 mg). Berdasarkan keputusan kajian yang diperoleh, buah pitaya merah mempunyai potensi kesihatan dalam mengurangkan faktor risiko kepada beberapa jenis penyakit seperti kardiovaskular, diabetes mellitus, mencegah hipertensi dan hiperkolesterolemia, melawan anemia dan membantu dalam meningkatkan tahap penglihatan.

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