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Full Length Research Paper

Assessment of nutritional and mineral composition of different parts of *Schismatoglottis bauensis*

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The study was carried out to assess nutritional and mineral composition of dried whole plant, leaf, stem, rhizome and root of *Schismatoglottis bauensis*. Proximate analysis was carried out by measuring total protein, fats, carbohydrate, ash and moisture contents following official methods of Association of Official Analytical Chemists. Macro- (Ca, Na, K) and micronutrients (Fe, Cu, Zn) were analyzed using atomic absorption spectrometry. Results revealed that dried whole plant showed highest crude fats and moisture content, whilst dried leaf exhibited the highest percentage of crude protein, and dried rhizome had the highest carbohydrate content. The calorific values for whole plant, leaf, stem, rhizome and root were 288.52, 309.19, 267.10, 303.71, and 295.37 kcal/ 100 g, respectively. Major minerals present in all the tested samples were potassium and calcium ranging from 2714 to 7213 mg/100 g and 216 to 1517 mg/100 g, respectively. Overall, the findings indicate this plant to be a good source of nutrient and minerals, which could be exploited as a valuable material for functional foods or nutraceuticals.

Key words: Proximate, nutritional, mineral, *Schismatoglottis bauensis,* Keladi Jantang, plant.

INTRODUCTION

Every plant has its own specific chemical, nutritional, and mineral composition besides having pharmacological properties. These constituents and nutrients are responsible for number of physiological functions in human body. The constituents like carbohydrates, fats and proteins play basic role in coping with human needs for energy and life process (Hoffman et al., 1998; Mathews et al., 1999; Dingman, 2002). Besides determination of above mentioned constituents, qualitative and quantitative analysis of trace elements in medicinal plants is also vital. Trace elements are involved in the synthesis of active components of the medicinal plants, which are responsible for their medicinal or toxic properties.

Therefore, quantitative studies on trace elements may provide some preliminary information on effectiveness and pharmacological properties of plants. This may also help in the assessment of toxic effects caused due to their elevated levels in plants (Devi et al., 2008). Medicinal plants have been used by marginal communities for the treatment of number of diseases (Latif et al., 2003; Adnan and Holscher, 2010). It is reported that various parts of the traditional medicinal herbs and edible plants including peel/pericarp, fruits, and seeds are rich in bioactive compounds e.g. vitamins, proteins, amino acids, carotenoids, phenolic compounds etc. and are very important for human nutrition. In recent past, ample amount of research evidence is accumulated which clearly demonstrate positive role of traditional medicinal plants in prevention or control of certain metabolic disorders like diabetes, heart diseases and certain types of cancers (Adnan and Holscher, 2010). A number of medicinal plants are also consumed as food besides their medicinal benefits. Therefore, evaluating their nutritional significance may help to understand the worth of these plant species (Pandey et al., 2006).

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Schismatoglottis bauensis or Keladi Jantang (in Malay) is a wild aroid plant, which may grow up to 1 m height. This plant, belonging to Araceae family, is widely distributed in soft, damp and shady habitats in Wasteland and is native to Borneo Island (especially found in Limbang Sarawak, Malaysia). This versatile tree has well-served the needs of rural communities by providing a potential means of food and nutrition with good therapeutic attributes. Interestingly, this plant has been traditionally used by Malaysians to treat various kinds of cancer, diabetes, ulcer and cardiovascular diseases. To the best of our knowledge, literature is scanty on the proximate and mineral composition of *S. bauensis*. This study, therefore, focuses on the nutritive and elemental composition of different parts of *S. bauensis.*

MATERIALS AND METHODS

Collection of plant materials

S. bauensis plants were collected during December 2010 from Limbang, Sarawak, Malaysia. Identification of plant was made at Diversity Unit of Herbarium, Institute of Bioscience, Universiti Putra Malaysia, where the voucher specimen SK 1921/11 was deposited.

Sample preparation

The collected plant was thoroughly washed several times with running tap water and then with deionized water, prior to separation into five different parts namely leaf, stem, root, rhizome and whole plant. All plant parts were dried at 40℃ in an elec tric oven. All the parts were individually freeze-dried (VirTisbenchtop K, Bieleveld, Germany) and stored at -80ºC prior to further analyses.

Nutritional composition

The moisture, crude fat, crude protein, ash, and carbohydrate contents of different parts of *S. bauensis* plant were determined following official methods of Association of Official Analytical Chemists (A.O.A.C, 2000). The nitrogen content was estimated using micro-Kjeldhal apparatus (Kjeltec^{TM} 2200 Auto Distillation Unit (FOSS Tecator, Sweden) and the protein content was calculated as N x 4.40. Carbohydrate content was determined by difference (100% - protein content – moisture content – ash content – crude fat content). A dry ashing method was used to determine the ash content by incinerating the sample in a furnace (Furnace 62700, Barnstead/Thermolyne, IA, and USA) set at 550ºC. The results for chemical composition were expressed in percentage of dry weight. The caloric value was calculated by summing up the percentages of crude-protein and carbohydrate multiplied by a factor of 4 (kcal/g) and total crude fat multiplied by a factor of 9 (kcal/ 100 g).

Minerals analysis

For minerals, amounts of sodium, potassium, calcium, copper, iron and zinc were measured using flame atomic absorption spectrometer (AA400, Analytic Jena AG, Jena, Germany). Appropriate working standard solution was prepared for each mineral. The calibration curves were obtained for concentration versus absorbance. The data were statistically analyzed using fitting of straight line by least square method. All the minerals were determined in plant under this investigation procedure. Laboratory procedures for the preparation and determination of macro- and micronutrients were used as described by Shah et al. (2009) for plant samples. The results for mineral content were expressed as milligram mineral /100 g dry weight (DW).

Statistical analyses

Data is reported as mean ± standard deviation from triplicate determinations. Analysis of variance (ANOVA) accompanied with Duncan's multiple range test (SPSS for windows, version 17) were conducted to identify differences among samples, p values of < 0.05 were regarded as significant.

RESULTS AND DISCUSSION

The nutritional composition for whole plant and different plant parts of *S. bauensis* is presented in Table 1. All the samples showed higher proportion of carbohydrate, followed by ash, moisture, crude protein and crude fat, respectively. The content of carbohydrates was significantly high, ranging from 63.14 to 73.23% DW in comparison to other chemical constituents. Among the tested samples, rhizome contained the highest carbohydrate content. The findings are in agreement with Salisbury and Ross (1992), who reported that products of photosynthesis can get translocated from leaf to food storage organs of the plant such as fruit, seed and rhizome. The moisture content for each freeze dried plant part and whole plant varied from 7.87 to 17.03% DW. The low moisture content of *S. bauensis* was indicative of its low susceptibility to microbial infection and possible long shelf-life (Adepoju, 2009). The protein content varied from 2.13 to 4.77% DW, which is lower in comparison to other plants of the same family, ranging over 23 to 30% DW (Lewu et al., 2009).

The highest protein content was exhibited by leaf samples ($p < 0.05$), which is almost 6-fold less than produced by *Colocasia esculenta* of 27% DW (Lewu et al., 2009). The values showed that the protein content is relatively low but it can contribute to the formation of hormones, which control a number of body functions including growth, repair and maintenance of body protein (Mau et al. 1999). Besides that, the protein content presented in Table 1 is much lower in comparison with studies reported on other plants, possibly due to value of protein conversion factor. The conversion factor used for this study was 4.4 as compared to traditional protein conversion factor 6.25, which is reported to be over-estimated for tropical plant parts (Milton and Dintzise, 1981).

The crude fat content in all samples was significantly low ranging from 0.44 to 1.19% DW, and this may be an advantageous information for people suffering from obesity (Lintas, 1992). The highest content of crude fat was found in leaves of *S. bauensis*. According to Smith (2009), fat content can be used for storage and transport forms of metabolic fuel. The crude fat may get added to

Table 1. The nutritional values of whole plant and different parts of *S. bauensis.*

Nutritional values (% dry weight)	Whole plant	Leaf	Stem	Rhizome	Root
Crude protein	3.03 ± 0.05^{d1}	4.77 ± 0.02^{b1}	2.62 ± 0.02^{a1}	2.13 ± 0.06^{e1}	3.77 ± 0.00^{c1}
Crude fat	1.19 ± 0.20^{c2}	1.29 ± 0.02^{c2}	0.55 ± 0.04^{b2}	0.25 ± 0.10^{a2}	0.44 ± 0.03^{ab2}
Ash	17.03 ± 0.47^{d3}	15.10 ± 0.04^{b3}	25.82 ± 0.10^{a3}	15.74 ± 0.00^{e3}	17.92 ± 0.00^{c3}
Moisture	17.03 ± 0.08^{c3}	9.22 ± 0.56^{b4}	7.87 ± 0.23^{a4}	8.65 ± 0.28^{ab4}	8.78 ± 0.11^{ab4}
Carbohydrates	66.42 ± 0.49^{d4}	69.63 ± 0.47^{c5}	63.14 ± 0.14^{a5}	73.23 ± 0.24^{b5}	69.09 ± 0.08^{c5}

Nutritional values were expressed as percent dry weight (% DW). All thevalues are means of three replicates and data is reported as mean (n=3) ± standard deviation (n=3). Means within each row labeled with different letters (a–c) and with number (1-5) for each column are significantly (P < 0.05) different according to Duncan's multiple range test.

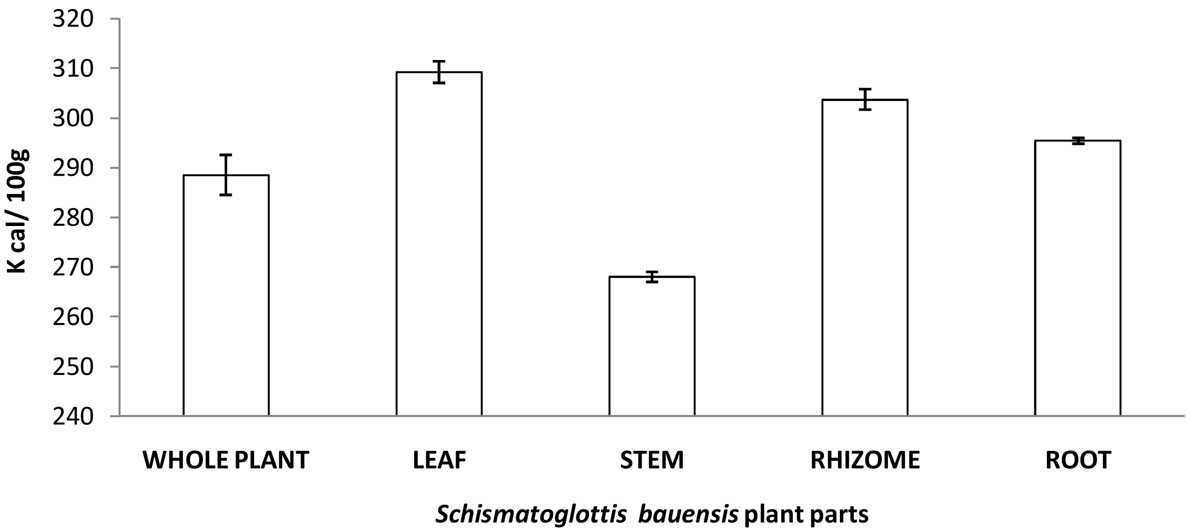

Figure 1. Energy values of whole plant, leaf, stem, rhizome and root of *Schismatoglottis bauensis*.

the caloric value extractable from plant for metabolic activities. As the highest crude fat was demonstrated by leaf samples, the highest caloric values were also exhibited by leaf sample, followed by rhizome, root, and whole plant, whilst the lowest caloric values were exhibited by stem (Figure 1). The caloric values were ranging over 267 to 309 kcal/100 g DW, indicating it asan important source of energy.

As shown in Table 1, stem showed the highest ash content, followed by root, whole plant rhizome and leaf. Michael and David (2002) reported that ash content is useful in grading the plant material based on their mineral composition. The mineral composition of the plant is given in Table 2. The essential minerals are usually divided into two groups, the macroelements and microelements. In the five analyzed samples, the most abundant macroelement was potassium, followed by calcium. Among all the samples, stem showed the highest potassium content, and its amount was approximately 2 fold higher than leaf, whole plant and rhizome ($p < 0.05$). The potassium content in all the samples was especially high in comparison to sodium; contributing very low Na/K ratio, which is reported to be favorable for lower incidences of hypertension (Choi et al. 2011). Straub, (2007) reported that high value of calcium in diet is responsible for maintaining the biological role in mediating vascular contraction and vasodilatation, muscle contraction, nerve transmission and glandular secretion.

Interestingly, all the tested samples showed significantly high amounts of calcium; with rhizome being the highest. On the other hand, microelements tested included iron, zinc and copper. The microelements content ranged between 15.08 to 21.58 mg/100 g, 19.26 to 48.81 mg/100 g and 1.13 to 4.40 mg/100 g for iron, zinc and copper, respectively among different samples. Iron is known to be a component of some metalloenzymes, myoglobin and hemoglobin (Ahmed and Chaudhary, 2009), which is needed in the transport of oxygen and carbon dioxide during respiration or cellular

Table 2. Amount of macro- and microelements in whole plant and different parts of *Schismatoglottis bauensis.*

Minerals	Whole plant	Leaf	Stem	Rhizome	Root
Na	22.22 ± 3.20^{ab4}	17.39 ± 4.74^{a4}	36.73 ± 0.07^{c5}	38.14 ± 1.78^{c6}	24.88 ± 1.41^{b6}
K	3846 ± 141.00^{b1}	3849 ± 112.00^{b1}	7213 ± 581.00^{c1}	3610 ± 122.23^{b1}	2714 ± 141.43^{a1}
Ca	1243 ± 17.54^{b2}	1388 ± 98.00^{bc2}	1286 ± 129.26^{b2}	1517.1 ± 52.47^{c2}	216 ± 19.80^{a2}
Cu	3.627 ± 0.11^{b3}	4.399 ± 0.46^{c3}	1.269 ± 0.14^{a3}	1.1252 ± 0.03^{a3}	1.34 ± 0.04^{a3}
Fe	21.58 ± 1.44^{b4}	18.80 ± 1.12^{b4}	20.60 ± 1.52^{b4}	15.081 ± 0.24^{a4}	178 ± 2.83^{c4}
Zn	28.21 ± 0.07^{b5}	26.68 ± 1.33^{b5}	20.36 ± 1.64^{a4}	48.81 ± 1.77^{c5}	19.26 ± 0.76^{a5}

Mineral content was expressed as mg/100 g dry weight (DW). All the values are means of three replicates and data is reported as mean (n = 3) ± standard deviation (n = 3). Means within each row labeled with different letters (a–c) and with number (1-5) for each column are significantly ($p < 0.05$) different according to Duncan's multiple range test.

metabolism. The hemoglobin (containing iron) also serves as buffer to regulate changes in blood pH (Kamshilov and Zaprudnova, 2009). Zinc serves as major function in stabilizing the tertiary structure of enzymes (Vallee et al., 1991). According to FAO's food balance data, about 20% of the world's population could be at risk of zinc deficiency. The average daily intake is less than 70 µg/ day (Holt and Brown, 2004).

Thus, consuming *S. bauensis* as part of diet could make up the Zn deficiency. Copper (Cu) concentration in all the plant parts was relatively low (1.13 to 4.40 mg/100 g DW). Interestingly, all the tested plant parts of *S. bauensis* were within acceptable range for copper, 2 to 5 mg intake per day set by WHO (Anonymous, 1998). Copper contributes towards iron and energy metabolism (Hussain et al., 2010). Moreover, these micronutrients are involved in various biological processes, as a component of protein or essential components for numerous enzymes required for oxidative, lipid, amino acid or carbohydrate metabolism (NRC/NAS, 1989). Our studies have shown that there is variation in proximate and elemental composition of whole plant, leaf, stem, rhizome and root of *S. bauensis*. All the plant parts exhibited good nutritional qualities. Besides that, this plant could be well integrated into food and medicine considering the results of this investigation. However, more detailed work is needed to confirm the hypothesis, which may include investigations on biological activities and identification of bioactives.

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