Nutritional Composition of Black Potato (Plectranthus rotundifolius (Poir.) Spreng.) (Synonym: Solenostemon rotundifolius)

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Abstract: Plectranthus rotundifolius (synonym: Solenostemon rotundifolius) (black potato) is an underutilised nutrient-rich crop that has the potential to contribute to food and nutritional security. We examined the macronutrient and selected mineral content of black potato bought at a morning market located in the state of Pahang, Peninsular Malaysia. The proximate composition of the tubers observed in % were, moisture (78.14 ± 0.84); crude protein (0.84 ± 0.06); crude fat (0.48 ± 0.06); crude fibre (2.03 ± 0.12); ash (1.63 ± 0.13); carbohydrate (18.92 ± 0.73) and energy in kcal/100g (83.32 ± 3.46). The mineral content observed in mg/kg were calcium (336.57 ± 21.71), iron (48.20 ± 3.64), potassium (12025.07 ± 485.33), magnesium (1346.63 ± 101.24), sodium (68.23 ± 2.62), manganese (6.67 ± 0.21) and phosphorus (978.00 ± 7.72). Comparison of black potato with some popular tubers such as potato, sweet potato and cassava found that black potato had less crude protein and crude fat. The carbohydrate and the energy contents of black potato were within the same range as potato and sweet potato but lower than those observed in cassava. The ash content of black potato was higher than that of potato, sweet potato and cassava and it also had a higher mineral content. Compared with popular tuber crops such as potato, sweet potato and cassava, black potato was observed to have higher mineral content that fulfils the requirements of the Recommended Nutrient Intake as outlined in the Dietary Guideline for American male and female aged between 31 to 50**.**

Index Terms: *Plectranthus rotundifolius*, *Solenostemon rotundifolius*, black potato, ubi kemili, underutilised, nutritional composition, mineral content

1 INTRODUCTION

Tuber crops rank second after cereals and grain legumes as food crops providing carbohydrate [1],[2],[3],[4] and contribute about six percent of the world's dietary energy [5] with an annual global production of approximately 836 million tonnes [2]. Tuber crops have edible carbohydrate-rich storage organs or `tubers' that develop wholly or partly underground from the stems [2],[3]. Potato, sweet potato and cassava are among the popular tuber crops that are widely consumed around the world contributing to 90% of the global production [2]. Among such tubers is a rare tuber, *Plectranthus rotundifolius* (synonym: *Solenostemon Rotundifolius*) [6],[7]; an underutilised tuber crop that is gaining interest due to its nutritional content and dietary potential [8],[9],[10],[11],[12]. Studies have been conducted to evaluate its potential to; improve diet quality [8]; antioxidant properties [13],[14],[15]; glycaemic response [16],[17]; prebiotic quality [18] and development of food products and functional food properties [12],[19],[20] because of its untapped potential as an alternative food source and to augment income [7],[9],[12].

Black potato originates from tropical Africa, where it is still found as a native plant in East Africa, but can now be found cultivated in other parts of the world including countries like Sri Lanka, India, Indonesia, Thailand and Malaysia [6],[7],[9],[11],[21],[22],[23],[24],[25],[26]. Common names of this potato include Black potato, Hausa potato, Country potato, Coleus potato, Chinese potato, Zulu potato, Frafra potato, Sudan potato and "ubi kemili" [6],[17],[22],[24],[27]. Black potato is a perennial herbaceous crop belonging to the Lamiaceae mint family [17],[21],[24]. It is noted to be tolerant to high temperature and rainfall and prefers well-drained, loose or sandy soil with direct sunlight [6],[21],[24],[25],[27]. It is a smallholder crop, mainly cultivated by women as subsistence food where the tubers are grown, dried and stored for times of shortage [24]. It is not primarily a cash crop, but part of the harvest is sold, from which African women have derived considerable income [6],[11],[24].

Black potato tubers are smaller than the commercial potato and are oval-shaped (Fig.1). They have dark brown skin with pale yellow flesh. The tubers are mostly eaten boiled, sautéed, mashed or peeled and fried [9],[12]. They are also milled into flour and made into various food products including breakfast porridge [6],[23],[24],[26]. Its products have been cited for use in treating burns, wounds, sores, insect bites and allergies [21]. Other uses include treatment for stomach pain, nausea, vomiting, diarrhoea, mouth and throat infections and are used as purgative, carminatives and as antihelmintic [6],[9],[10],[28]. Black potato is also noted for its antioxidant content which has been studied for its potential to mediate cancer cells [14],[15]. Due to its low glycaemic index, black potato can also reduce the risk of diabetes and obesity [19],[23],[25].

a) b)

Fig 1. Plectranthus rotundifolius, a) photo taken at the morning market where the tubers were procured; b) size comparison to a Malaysian 10 cent coin (18.8 mm in diameter).

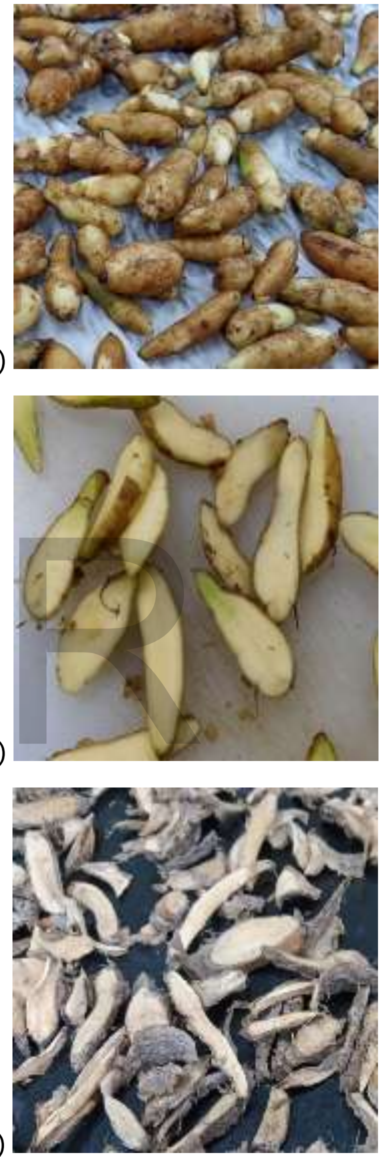
It has been reported that 100 g of black potato has 21 g of carbohydrate, slightly higher than the same portion of potato (17 g) and sweet potato (20 g) [9],[22],[23],[25]. Compared with other tubers, a standard serving provides a large percentage of the daily required calcium, vitamin A and more than the daily required iron [9],[12],[24]. The absence of gluten in these tubers may serve as an advantage as it can be an alternative food source for those who are sensitive to gluten products or are celiac [16].

Studies on black potato indicate that this underutilised crop has the potential as an alternative food and nutrition source and may generate income. To the best of the authors' knowledge, there is little data on the crop obtained from Malaysia. The objective of this research was to investigate the nutritional composition of the crop which would further supplement the existing knowledge on the nutritional implications as a food source. For this, the macronutrient and selected mineral content were benchmarked against some popular tubers already on the market.

2 MATERIALS AND METHODS

2.1 Raw material

Black potatoes (Plectranthus rotundifolius) were procured from a morning market; Pasar Pagi Maran, Pahang, Malaysia in November 2019. The materials were reportedly grown in Bachok, Kelantan, Malaysia. Black potatoes are found to be diverse in shape, size and colour. The procured tubers had blackish brown skin with pale yellow flesh (Fig. 2a & 2b). The dimension of the tubers ranged between 3.0 and 5.0 cm long and 1.0 and 2.0 cm diameter.



a) b) c)

Fig 2. *Plectranthus rotundifolius*, a) washed and cleaned; b) sliced c) dried at 105 °C

2.2 Sample preparation

The tubers (≈ 2 kg) were cleaned under running tap water to remove soil particles and debris. Fine roots were removed to leave only tubers. The tubers were sliced and dried in an oven at 105 °C for 24 h or until the sample reached a constant weight (Fig. 2c). The dried tubers were ground using a household dry blender in batches and pooled. The ground samples were stored in labelled airtight containers before analysis. Proximate analysis was carried out using standard methods outlined by the National

Technical Working Group of Malaysia Food Composition Database [29]. Selected mineral content was determined for the dried sample in accordance with AOAC methods by an ISO/IEC 17025 accredited laboratory, UNIPEQ, Malaysia. Triplicate samples were carried out for all the analysis.

2.3 Analytical Analysis

Moisture: Approximately 5 g of fresh sample was dried in a laboratory oven (Venticell VC55) at 105 °C for 16 h or until constant weight was achieved.

Crude Protein: Protein content was measured by estimating the nitrogen content in the sample using a semi-automated Kjeldahl method. This involved three steps, manual digestion; automatic distillation and titration. Approximately 2 g of sample was digested in 20 ml concentrated sulphuric acid (> 98 % H_2SO_4) with one mineralised catalyst on a conventional digester (Gerhardt, KI 11/26) for at least 2 h or until the solution became clear/colourless. This was followed with second step, distillation; 50 ml deionized water (dH_2O) and 70 ml 32 % sodium hydroxide (NaOH) was added into the colourless digested sample and distilled into 60 ml 2 % boric acid (H_3BO_3) using automated distillation equipment (Gerhardt, Vapodest 400). In the final step, the distillate with borate ion was titrated against standardized 0.1 M hydrochloric acid (HCl) using an automatic titrator (Metrohm, 877 Titrino plus) to obtain the nitrogen percentage and the protein was calculated by multiplying by 6.25.

Crude Fat: Crude fat was determined using a continuous solvent extraction method with a standard Soxhlet setup from Gerhardt. Approximately 2 g of dried sample was wrapped in a filter paper and inserted into a cellulose thimble and then placed in an extraction chamber. Approximately 200 ml petroleum ether was added into a pre-weighted - pre-dried boiling flask with 2-3 pieces of boiling stones. The extraction was carried out for 3 h. After the extraction was complete, the solvent was collected in the boiling flask. The boiling flask was placed in a water bath (70 °C) to evaporate the solvent, the flask is further dried in the oven (105 °C). The crude fat content was calculated as the weight of the fat removed from the sample.

Crude Fibre: The crude fibre was measured using Fibrebag System (Gerhardt, Fibretherm FB6). There were four steps involved. Step one; approximately 2 g of the sample was de-fatted by rinsing with petroleum ether to obtain a clear solution. Step two involved two separate digestion processes, acid digestion using 0.13 mol/L H_2SO_4 (to remove free sugar and starch) and alkaline digestion using 0.23 mol/L NaOH (to remove protein and carbohydrate). The sample was further digested for 30 mins and rinsed with hot water twice after each digestion process. After digestion was completed, the sample was dried overnight at 105 °C (Venticell, VC55) and incinerated in a muffle furnace (Thermolyne, F6010) at 550 °C for 4 h.

Ash: Ash was determined by incinerating 5 g of the sample in a muffle furnace (Thermolyne, F6010) at 550 °C for 4 h.

Carbohydrate: Carbohydrate was obtained by difference calculation, 100 – (sum of percentage in moisture, ash, protein and fat).

Energy: The total energy content was determined by the sum of fat, protein and carbohydrate multiplied with factors 9.0, 4.0 and 4.0 respectively, the result was expressed in kilocalories per 100 g sample.

3 RESULTS AND DISCUSSION

3.1 Proximate composition

Table 1 shows the proximate composition of black potato compared with the values reported by Leung et al. [30] and other tuber crops: potato, sweet potato and cassava. In this study, the proximate data differed from that reported by Leung et al. [30]. We found crude protein (0.84%) to be lower whereas all other proximate data were within the same range or slightly higher than previously reported.

It was found that 100 g of black potato had 21 g of carbohydrate, slightly higher than the same portion of potato (17 g) and sweet potato (20 g) [22]. This study reports lower carbohydrate (18.9 g) than cited by Enyiukwu et al. [22], but still slightly higher than that found in potato which also contributes to a slightly higher energy content. A notable attribute of the black potato is the ash content compared to the other tubers. Black potato (1.63 %) was observed to have the highest ash content compared with potato (1.11 %); sweet potato (0.99 %) and cassava (0.62 %). This higher ash content contributed to the higher mineral content which is discussed below.

3.2 Mineral composition

Table 2 presents the mineral composition of black potato compared with potato, sweet potato, cassava and the Recommended Nutrient Intake (RNI) for adult male and female aged 31 to 50 [31]. Black potato had a higher composition of all the analysed minerals compared to the other tubers. Potassium and magnesium are notably high; potassium (12025 mg/kg) almost three times more than potato and six times more than cassava and magnesium (1347 mg/kg) is higher by five times compared to all the listed tubers. Phosphorus (978 mg/kg) was observed to be nearly double that of potatoes but almost four times that of cassava. The mineral content observed in black potato meets the recommended nutrient intake for both female and male aged between 31 to 50 for most of the nutrient except for calcium and sodium.

Minerals are essential for bodily function, macro-minerals (calcium, potassium, magnesium, sodium, phosphorus) are needed in a larger quantity compared to the micro-minerals (iron and manganese). These two groups of minerals are equally important and cannot be synthesized biochemically by the body. Mineral deficiencies have been associated with stunting, wasting, anemia and other disorders [32],[33]. It was reported that the number of undernourished people has increased from 777 million in 2015 to 815 million in 2017 with an estimated 155 million children having stunted growth [8].

4 CONCLUSION

Underutilised tuber crops offer an important agronomic advantage as staple foods because of their favourable adaptation to diverse soil and environmental conditions and as part of the diversification of farming systems with minimum agricultural inputs. The tuber *Plectranthus rotundifolius*, known as *ubi kemili* by the local community in Malaysia was examined for its proximate composition and selected mineral. The analysis shows that the crop has untapped potential uses in the human diet particularly in addressing the recommended nutrient intake requirements.

Table 1. Proximate Composition of *Plectranthus rotundifolius* compared to other tubers

Component	This study	Leung *et al.* 1968	Potato[1]	Sweet potato[1]	Cassava[1]
Moisture (%)	78.14 ± 0.84	75.60 - 78.00	79.25	77.28	59.68
Crude protein (%)	0.84 ± 0.06	1.30 - 1.90	2.05	1.57	1.36
Crude fat (%)	0.48 ± 0.06	0.20 - 0.40	0.09	0.05	0.28
Crude fibre (%)	2.03 ± 0.12	1.00 - 1.10	ND	ND	ND
Ash (%)	1.63 ± 0.13	0.90 - 1.00	1.11	0.99	0.62
Carbohydrate (%)	18.92 ± 0.72	18.80 -21.90	17.49	20.12	30.06
Energy (kcal/100g)	83.33 ± 3.42	84.00 - 94.00	77.00	86.00	160.00

Values in this study are expressed as mean ± standard deviation (n = 3); ND – No data; Fat, Protein and Carbohydrate multiplied with factors 9.0, 4.0 and 4.0; [1]Source: USDA [34]

Table 2. Mineral Composition of *Plectranthus rotundifolius* compared to other tubers

Component	This study	Potato[1]	Sweet Potato[1]	Cassava[1]	RNI (Age 31 - 50) Female (1800)[2]	Male (2200)[2]
Calcium (mg/kg)	337	120	300	160	1000	1000
Potassium (mg/kg)	12025	4250	3370	2710	4700	4700
Magnesium (mg/kg)	1347	230	250	210	320	420
Sodium (mg/kg)	68	60	550	140	2300	2300
Phosphorus (mg/kg)	978	570	470	270	700	700
Iron (mg/kg)	48	8.1	6.1	2.7	18	8
Manganese (mg/kg)	7	1.53	2.58	3.84	1.8	2.3

Values in this study are expressed as mean ± standard deviation (n = 3); [1]Source: USDA [34]; [2]Source: USDA [31]

AUTHORS CONTRIBUTIONS

Gomathy Sethuraman: Investigation, Resources, Data Curation, Writing – Original Draft. Nur Marahaini Mohd Nizar: Resources, Data Curation, Writing - Editing. Fatin Nadia Muhamad: Resources, Data Curation. Ebrahim Jahanshiri: Funding acquisition. Peter J. Gregory: Conceptualization, Supervision, Writing - Review and Editing. Sayed Azam-Ali: Funding acquisition, Project Administration, Writing - Review and Editing.

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