

Comparison of the Fatty Acid, Amino Acid, Mineral and Antioxidant Content of Sweet Potato Leaves Grown on Matsu Island and Mainland Taiwan

Lu Te Chuang¹ • Robert H. Glew² • Yuan Chen Wang¹ • Pei Wun Yao¹ • Chih Cheng Lin¹ • Jack M. Presley³ • John Schulze³ • Chien Wei Hou^{1*}

¹ Department of Biotechnology, Yuanpei University, Hsinchu, Taiwan

² Department of Biochemistry and Molecular Biology, University of New Mexico School of Medicine, Albuquerque, New Mexico, U.S.A.

³ Genome Center Proteomics Core Facility, University of California, Davis, California, U.S.A.

Corresponding author: *rolis.hou@mail.ypu.edu.tw.

ABSTRACT

Sweet potato leaves (SPL) are a green leafy vegetable valued for their low carbohydrate and high essential-nutrient content. The aim of this study was to increase knowledge of the nutrient composition of SPL by analyzing SPL cultivated on Matsu and Hsinchu, Taiwan for antioxidants, amino acids, fatty acids, and minerals and trace elements. With the exception of antioxidants, in general, SPL from Matsu contained significantly more of these nutrients than those from Hsinchu. Methanol extracts of Hsinchu SPL contained 359 mg/g dry wt of polyphenols compared to 129 mg/g in leaves from Matsu and twice the radical-scavenging activity of the Matsu specimens. The leaves from Matsu contained more of 7 of 11 essential minerals than those from Hsinchu, including: Zn, Fe, Cr, Se, Ca, Mg, and P. Matsu and Hsinchu SPL contained 13.8 and 17.1% protein ($P = 0.001$), respectively, and the proportions of all essential amino acids in both sets of specimens, except for methionine plus cysteine (score, 46-54), exceeded those of a World Health Organization reference protein which are set at 100. The fatty acid content of the leaves from both sites was low (1.54-1.60%); however, the healthful ω -3 essential fatty acid α -linolenic acid accounted for 48.3-53.4 of the total, whereas the ω -6 essential fatty acid, linolenic acid contributed only about 12% to the fatty acid total. In conclusion, these results demonstrate that while the leaves of sweet potato are a good source of many essential nutrients, the amounts of protein, antioxidants, and minerals and trace elements and the fatty acid composition of SPL in Taiwan varied significantly between the two sites where they were cultivated. These differences are likely related to climate and soil quality.

Keywords: *Ipomoea batata*, leaves, nutrients

Abbreviations: GAE, gallic acid equivalents; H, Hsinchu; M, Matsu Island; ROS, reactive oxygen species; SPL, sweet potato leaves

INTRODUCTION

The leaves of sweet potato (*Ipomoea batata*) are considered a green leafy vegetable and as such are low in calories but fat high in protein, dietary fiber (Johnson and Pace 2010), essential minerals (e.g., calcium and iron), certain vitamins (e.g., ascorbic acid, folate, vitamin K) and the phytochemicals β -carotene and lutein (Chandrika *et al.* 2010). Although the leaves of sweet potato are used in most parts of the world as an animal feed or are consumed by humans mostly as a 'famine food' during periods of food scarcity, populations in Asia relish sweet potato leaf and consume the vegetable on a regular basis. However, it is widely acknowledged that the nutrient content of a particular plant food can vary considerably between countries and even regions within a country due to variations in temperature, rainfall, fertilizer use and the nutrient content of the soil (Greenfield and Southgate 1992; Falcone *et al.* 2004).

Sweet potato is native to tropical America and was introduced into Taiwan in the 16th Century. Immediately after World War II when food was scarce in Taiwan, the leaves and stems of sweet potatoes became critically important components of the diet, and continue to the present time to be appreciated for their taste and nutritional attributes vis-à-vis human health (Gordon *et al.* 1999).

Sweet potato plays an especially key role in human nutrition on the small, rocky islands off the coast of Taiwan because of its hardiness and ability to grow in relatively poor soil where the more common green leafy vegetables such as spinach, cabbage and lettuce do not do well (Amede

et al. 2004). Furthermore, sweet potato resists the strong winds and heavy rain that blow across the island throughout most of the year. Matsu is one such island in the Taiwan Strait (Wu *et al.* 2007).

Matsu is a 10.4 km² island off the coast of Taiwan and has a subtropical maritime climate. Since it is located close to mainland China and to the northwest of Taiwan, the average annual temperature on Matsu is about 5°C lower than that of Taiwan. In geological terms, since the island was formed from a volcanic cone the reddish-yellow soil is rocky and poor, causing the inhabitants to rely mainly on sweet potato leaves for the vegetable component of their diet.

In light of the fact that sweet potato leaves serve as the main green leafy vegetable in the diet of the people of Matsu and appreciating the fact that geography and soil conditions can have a large impact on the nutrient composition of a plant (Greenfield and Southgate 1992; Martz *et al.* 2006), we were interested in knowing about their content of essential amino acids, fatty acids, minerals and trace elements, and antioxidants. We therefore collected leaves from sweet potatoes grown on Matsu and compared their content of the afore-mentioned nutrients with those of sweet potato leaf grown in Hsinchu, Taiwan.

MATERIALS AND METHODS

Materials

Leaves were harvested in June 2010 from sweet potato (*Ipomoea batata*) plants growing on the island of Matsu and in Hsinchu, Taiwan. During the period when the leaves were growing and collected, the 24-h daily temperature range on Matsu was 14.5-19.6°C and that in Hsinchu was 20.3-25.0°C. The leaves were rinsed thoroughly with tap water to remove extraneous contamination, dried for 24 h at 50°C in a hot-air oven, ground to a fine powder with the aid of a stainless-steel mill and finally dried to constant weight in a vacuum desiccator.

With regard to the extraction procedure, triplicate one-gram samples of sweet potato leaf powder from each site was mixed with 100 mL of methanol: water (80/20, v/v), vortexed vigorously for 5 min, and then centrifuged at $2,000 \times g$ for 10 min. Finally, the extracts were clarified and sterilized by filtration through a sterile 0.25 µm Millipore membrane (Millipore, Bedford, USA).

2',7'-Dichlorodihydrofluorescein diacetate (H₂DCF-DA) was purchased from Molecular Probe (Eugene, Oregon, USA).

Estimation of the reactive oxygen species (ROS)-scavenging capacity of methanol extracts of sweet potato leaf

Reactive oxygen species (ROS) were generated using 2',7'-dichlorodihydrofluorescein diacetate (H₂DCF-DA) as described elsewhere (Brubacher and Bols 2001). H₂DCF-DA was dissolved in methanol and de-acetylated in cell-free solution following published methods (Hou *et al.* 2003). A solution consisting of 10 µM H₂DCF and 1 mM H₂O₂ alone or with clarified, sterile sweet potato leaf extract (1 µl/mL) was incubated in the dark at room temperature for 5 min. A 0.1-mL aliquot of the reaction mixture was then pipetted into the wells of 96-well plates and cellular fluorescence was determined with the aid of a Fluoroskan Ascent fluorometer (Labsystems Oy, Helsinki, Finland) using excitation and emission wavelengths of 485 and 538 nm, respectively. The concentration of ROS is expressed in terms of nM DCF.

Determination of total phenolic compounds

The total quantity of phenolic compounds in the methanol extracts of leaves was estimated and expressed in terms of 'gallic acid equivalents' (GAE) using the method described by Singleton *et al.* (1999). The methanolic extracts of sweet potato leaves were serially diluted with methanol and 0.1 mL aliquots of these solutions were transferred to 10 mL volumetric flasks containing 0.5 mL of undiluted Folin-Ciocalteu reagent. One minute after mixing, 1.5 mL of 20% (w/v) Na₂CO₃ was added, and the total volume was made up to 10 mL with double-distilled water. After incubation at room temperature for 60 min, the absorbance was determined at 760 nm and compared to a gallic acid calibration curve prepared at the same time to provide a measure of the GAE in each extract.

Fatty acid analysis

Prior to lipid extraction, powdered specimens of sweet potato leaves were vacuum dried using an Eyela centrifugal evaporator CVE-1000 (Tokyo, Japan) for 12 h. Total lipids from samples were extracted according to a modification of the Folch method (Folch *et al.* 1957). Briefly, approximately 0.25 g of sample was extracted with 20 mL of chloroform/methanol (2: 1, v/v) at room temperature for 1 h. The extracted lipids in the chloroform phase were separated from the aqueous phase by shaking and partitioning with 4 mL of 0.9% (w/v) NaCl, the chloroform layer was collected and evaporated under a stream of nitrogen gas. The lipids were then dissolved with 5 mL of chloroform.

To prepare fatty acid methyl esters, 0.2 mL of sample was evaporated under a stream of nitrogen gas and then treated with 14% (w/v) methanolic boron trifluoride (BF₃) for 20 min at 95°C (Morrison and Smith 1964). The fatty acid methyl esters were extracted into *n*-hexane, analyzed and quantified using an Agilent 6890 gas chromatograph equipped with a flame-ionization detector and a fused-silica capillary column (Omegawax; 30 m × 0.32

mm, i.d., film thickness 0.25 µm, Supelco, Bellefonte, PA, USA). Helium was used as the carrier gas. The injector was set at 205°C and the detector was at 235°C. The temperature of the oven was initially 140°C, and then raised to 205°C at 6°C/min and held for 20 min. The fatty acid peaks were identified by comparing their retention times to those of a standard mixture of fatty acid methyl esters (RL-461, Nu-Chek-Prep, Inc., Elysian, MN, USA). Quantification was carried out using the technique of internal standardization with triheptadecanoin (Sigma, St. Louis, MO, USA).

Amino acid analysis

Twenty milligrams of dried, milled sweet potato leaf were hydrolyzed in 6 N HCl containing 0.1% (w/v) phenol at 110°C for 24 h under vacuum, and the resultant amino acids were separated and quantified using a Hitachi 8800 Chromatographic System (Tokyo, Japan) using a Transgenomic column, Pickering buffers, and a customized gradient profile optimized for amino acid resolution. For determination of methionine and cysteine, samples were oxidized with performic acid (Hirs 1967) prior to acid hydrolysis. The reproducibility of the method ranged from 0.6-11% for the amino acids reported. Tryptophan was not determined.

Mineral analysis

The amounts of various minerals and trace elements in sweet potato leaves were determined by Zeeman atomic absorption spectroscopy. The exhaustively-dried, powdered leaves were weighed, dissolved in 80% (w/v) HNO₃, and analyzed using a Hitachi Z-2300 atomic absorption spectrometer (Tokyo, Japan) according to the method described by Martin *et al.* (2000). Digested samples were diluted 1 to 50-fold as required using 0.5% (v/v) HCl. With the aid of an auto-sampler, 20 µL aliquots of the diluted samples and 5 µL of 1.5% (v/v) HNO₃ were injected into the graphite furnace. Three replicates of each specimen were analyzed.

Statistical analysis

All data were expressed as the mean ± SEM. For single variable comparisons, a Student's *t*-test was used. For multiple variable comparisons, data were analyzed by one-way analysis of variance (ANOVA) followed by Scheffe's test. *P*-values less than 0.05 were considered significant.

RESULTS

Fatty acid analysis

As shown in **Table 1**, three fatty acids accounted for up to 85% of the fatty acids of the total lipids extracted from two batches of sweet potato leaves: specifically, the omega (ω)-3 essential fatty acid α-linolenic acid (18:3n-3), the ω-6 essential fatty acid linoleic acid (18:2n-6), and the saturated fatty acid palmitic acid (16:0) accounted for 48.3, 12.3, and 20.6% of the total fatty acids in a total lipid extract of sweet potato leaves from Taiwan, and 53.4, 11.9, and 18.8% of those from Matsu.

Like many other green leafy herbs or vegetables in other parts of the world (Ndlovu and Afolayan 2008; Glew *et al.* 2009, 2010a, 2010b), the total fatty acid content of sweet potato leaves was relatively low, ranging from 1.55 to 1.60% of the dry weight of the milled leaves (**Table 1**). Since linoleic acid and α-linolenic acid are essential fatty acids in humans, it is worth pointing out that 50 g of dried sweet potato leaves would contribute about 0.4 g of α-linolenic acid but only 0.1 g of linoleic acid to the diet. The daily intakes of α-linolenic acid and linoleic acid recommended for adults are in the ranges 1.1-1.6 g and 13-17 g per day, respectively (Food and Nutrition Board 2005).

A noteworthy aspect of the fatty acid compositions of sweet potato leaf is the favorable linoleic acid/α-linolenic acid ratio of 0.26 (0.01) for Taiwan-grown sweet potato and 0.22 (0.0) for those from Matsu (*P* < 0.001), respectively; a ratio less than 1.0 has been considered as healthy (Simopoulos *et al.* 1999; Harris *et al.* 2009).

Table 1 Fatty acid composition (mass %) and content (mg/g dry weight) of sweet potato leaves.

Sample	Normalized (%)			Weight (mg/g)		
	Taiwan	Matsu	<i>p</i> -value	Taiwan	Matsu	<i>p</i> -value
C14:0	2.76 (0.12)	3.73 (0.20)*	0.002	0.44 (0.054)	0.58 (0.01)*	0.013
C14:1	0.34 (0.07)	0.40 (0.07)	0.387	0.06 (0.017)	0.06 (0.01)	0.628
C15:0	0.21 (0.05)	0.23 (0.09)	0.752	0.03 (0.005)	0.04 (0.02)	0.787
C16:0	20.6 (0.2)	18.8 (0.3)*	0.001	3.30 (0.321)	2.91 (0.14)	0.131
C16:1	0.89 (0.13)	0.88 (0.21)	0.957	0.14 (0.024)	0.14 (0.04)	0.851
C16:2	1.49 (0.06)	1.08 (0.04)*	0.001	0.24 (0.030)	0.17 (0.01)*	0.016
C16:3	0.74 (0.14)	1.16 (0.15)*	0.022	0.12 (0.023)	0.18 (0.03)*	0.048
C18:0	5.73 (0.19)	4.56 (0.14)*	0.001	0.92 (0.082)	0.71 (0.03)*	0.013
C18:1n-9	4.35 (0.76)	1.47 (0.02)*	0.003	0.70 (0.182)	0.23 (0.01)*	0.011
C18:1n-7	0.35 (0.04)	0.27 (0.06)	0.122	0.06 (0.010)	0.04 (0.01)	0.174
C18:2n-6	12.3 (0.4)	11.9 (0.0)	0.169	1.97 (0.254)	1.85 (0.11)	0.476
C18:3n-3	48.3 (1.3)	53.4 (0.4)*	0.003	7.73 (0.657)	8.28 (0.57)	0.333
C20:0	1.31 (0.05)	1.32 (0.03)	0.726	0.21 (0.014)	0.21 (0.01)	0.679
C22:0	0.70 (0.16)	0.76 (0.34)	0.784	0.11 (0.021)	0.12 (0.06)	0.837
Total	100	100	-	16.0 (1.6)	15.5 (1.0)	0.348

* Each value represents the mean \pm SD of three independent experiments.
18:2n-6/18:3n-3 0.26 (0.01) 0.22 (0.00)

Comparison of the content of the total phenol content of sweet potato leaves from Matsu and Hsinchu

The data in **Fig. 1** show that the leaves of sweet potato grown in Hsinchu contained 2.8-fold more total polyphenols than leaves from plants grown on Matsu Island (359 versus 129 mg/g dry weight, respectively; $P < 0.001$).

Comparison of the amounts of ROS-scavenging substances in extracts of sweet potato leaves from Matsu and Hsinchu

To compare the antioxidant content of sweet potato leaves from Matsu and Hsinchu, Taiwan, we determined the capacity of methanol extracts prepared from triplicate samples of leaves collected at the two different sites to neutralize H_2O_2 (1 mM). As shown in **Fig. 2**, extracts of the leaves of Hsinchu-grown sweet potatoes contained about twice the content of ROS-scavenging substances compared to the leaves from the island of Matsu. This observation is consistent with the fact that the Hsinchu leaves contained significantly more polyphenols than the sweet potato leaves from Matsu (**Fig. 1**).

Mineral and trace elements in sweet potato leaves from Matsu and Hsinchu

A comparison of the content of 11 nutritionally important minerals and trace elements in sweet potato leaves cultivated in Hsinchu and Matsu is summarized in **Table 2**. Noteworthy is the fact that the leaves from Matsu contained significantly more of 7 of the 11 elements than those from Hsinchu: these included zinc, iron, chromium, selenium, calcium, magnesium and phosphorus. The minerals that were present in higher quantities in the Hsinchu leaves were potassium, copper, manganese and molybdenum.

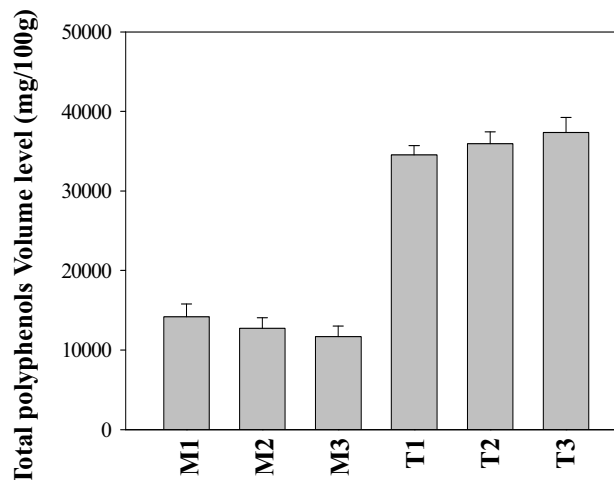


Fig. 1 Content of the total polyphenol volume of sweet potato leaves from Matsu and Hsinchu. The leaves of sweet potato grown in Hsinchu (T1, T2, T3, Taiwan, Hsinchu) contained more higher total polyphenol volume than leaves from plants grown on Matsu Island (M1, M2, M3). Values represent the mean \pm SD of three independent experiments.

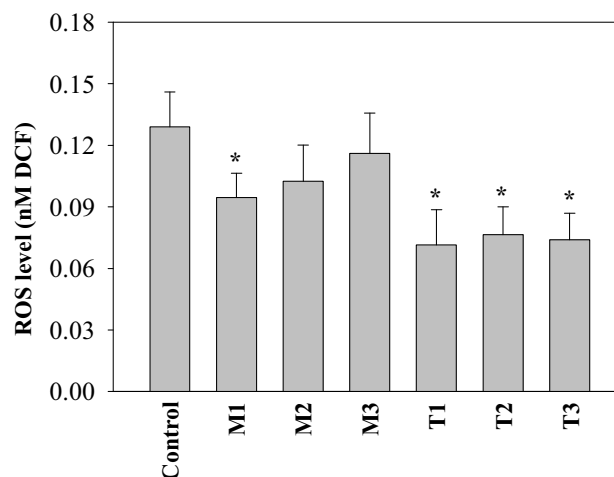


Fig. 2 Effect of sweet potato leaves on ROS generation. The scavenging effect of sweet potato leaves on ROS generation (mean \pm SEM) was assessed with H_2O_2 (1 mM) alone (control) or with addition of sweet potato leaves extract (1 μ L/mL) from Matsu (M1, M2, M3) and Hsinchu (T1, T2, T3, Taiwan, Hsinchu). Values represent the mean \pm SD of three independent experiments. * $P < 0.05$.

Amino acid content of sweet potato leaves from Matsu and Hsinchu

Based on the amino acid total and excepting tryptophan (**Table 3**), protein accounted for 13.8 and 17.1% of the dry weight of the sweet potato leaves cultivated in Hsinchu and on Matsu Island, respectively, and the 23% difference between the two values was significant ($P = 0.001$). As shown in **Table 4**, when compared with the World Health Organization reference protein (WHO 1985), the amino acid pattern of sweet potato leaf from Hsinchu and Matsu were similar and exceeded the scores for the WHO reference protein (a score of 100 is considered ideal) for all amino acids (and amino acid pairs) except the methionine plus cysteine (scores, 46-54). Tryptophan was not determined due to technical difficulties.

DISCUSSION

This study was predicated on the expectation that since the soil and climatic conditions on the rocky island of Matsu for general agriculture would be less favorable than those

Table 2 Comparison of the mineral content ($\mu\text{g/g}$ dry weight) of sweet potato leaves cultivated in Hsinchu, Taiwan and Matsu Island.

Mineral	Hsinchu	Matsu	p-value
Copper	11.3 (0.6)	8.4 (0.1)	0.02
Zinc	33.6 (1.0)	53.5 (0.7)	0.02
Iron	233 (12)	626 (20)	<0.0001
Potassium	25,200 (822)	18,500 (563)	<0.0001
Chromium	3.3 (0.1)	8.2 (0.1)	<0.0001
Selenium	0.3 (0.0)	0.5 (0.0)	0.0003
Calcium	8830 (74)	13,900 (801)	0.0008
Magnesium	2890 (96)	5220 (139)	<0.0001
Manganese	179 (9)	127 (9)	0.0002
Molybdenum	0.5 (0.0)	0.7 (0.0)	0.0006
Phosphorus	2590 (61)	5250 (95)	<0.0001

^aThe number in parentheses indicates one standard deviation.

Table 3 Comparison of the amino acid content (mg/g dry weight) of sweet potato leaves cultivated in Hsinchu and Matsu.

Amino acid	Hsinchu, Taiwan	Matsu Island	p-value
Aspartic acid	20.9 (0.1)	30.7 (3.8)	0.001
Threonine	6.96 (0.21)	8.10 (0.19)	0.002
Serine	6.02 (0.23)	7.52 (0.20)	0.001
Glutamic acid	18.9 (0.6)	22.5 (0.7)	0.002
Proline	7.25 (0.49)	7.99 (0.15)	NS
Glycine	6.95 (0.21)	8.26 (0.23)	0.002
Alanine	8.26 (0.34)	9.53 (0.18)	0.005
Valine	8.77 (0.21)	9.85 (0.25)	0.005
Isoleucine	6.62 (0.15)	7.44 (0.21)	0.005
Leucine	12.2 (0.42)	13.5 (0.1)	0.006
Tyrosine	4.98 (0.34)	6.04 (0.21)	0.01
Phenylalanine	8.24 (0.21)	11.4 (0.5)	0.0004
Histidine	3.56 (0.08)	4.37 (0.14)	0.001
Lysine	8.99 (0.24)	9.80 (0.24)	0.01
Arginine	7.81 (0.37)	10.7 (0.5)	0.001
Cysteine	1.89 (0.03)	1.97 (0.45)	NS
Methionine	0.78 (0.09)	0.87 (0.47)	NS
Total	138 (4)	171 (5)	0.001
Tryptophan was not determined.	The number in parentheses indicates one standard deviation.		NS, not significant.

Table 4 Comparison of the amino acid composition of sweet potato leaves cultivated in Hsinchu, Taiwan and Matsu versus the WHO reference protein.

Amino acid	WHO ideal ^a Hsinchu Matsu				
	% of total	% of total ^b	Score	% of total ^b	Score
Threonine	4.0	5.0	125	4.8	120
Valine	5.0	6.3	125	5.8	120
Isoleucine	4.0	4.8	120	4.4	110
Leucine	7.0	8.8	125	8.1	120
Tyrosine + phenylalanine	6.0	9.5	160	10.2	170
Methionine + cysteine	3.5	2.7	77	2.8	80
Lysine	5.5	6.3	110	5.8	105

^aWHO (1985)

^bData derived from Table 3.

on the main island of Taiwan, the nutrient content of leaves of sweet potato from Matsu would be inferior relative to leaves of sweet potato grown in Hsinchu. Contrary to expectation, however, was our finding that the leaves from Matsu were equal to or superior to those from Hsinchu in terms of their content of fatty acids (Table 1), minerals and trace elements (Table 2), and amino acids (Tables 3, 4). Antioxidants were the only exception to this generalization. Although the content of polyphenols (Fig. 1) and other oxygen radical-scavenging substances (Fig. 2) in methanol extracts of leaves of sweet potato from the two different geographical locations did differ markedly and significantly ($P < 0.001$), the leaves from Taiwan-grown plants contained 2 to 3-times more polyphenols and radical-scavenging activity than those from Matsu.

Although there were no gross differences in the fatty acid profiles of the total lipid extracts of the leaves from

Matsu and Taiwan proper, there was a small but statistically significant and noteworthy difference in the proportions of the two essential fatty acids, linoleic acid and α -linolenic acid, as evidenced by the fact the linoleic acid/ α -linolenic acid ratio was 20% higher for the sweet potato leaves from Taiwan compared to those from Matsu. It is well-established that the leaves of a particular plant growing in a relatively cool climate will produce lipids that contain a higher proportion of polyunsaturated fatty acids relative to its counterpart grown in a warmer climate (Falcone *et al.* 2004; Martz *et al.* 2006). Since α -linolenic acid is more unsaturated than linoleic acid and Matsu is colder, on average, than Taiwan proper by about 5°C, it was reasonable to find a lower ω -6/ ω -3 ratio for the lipids from the Matsu-grown sweet potato leaves compared to the leaves of sweet potatoes from Taiwan proper.

The total amount of fatty acid and the percentages of particular fatty acids we found in sweet potato leaves were similar to the fatty acid content and composition of spinach (Kuti and Kuti 1999), cabbage (Campas-Baypoli *et al.* 2009) and lettuce (Yoo *et al.* 2006) as well as 11 green leafy vegetables in Ghana that we reported recently (Glew *et al.* 2009, 2010a, 2010b), including *Hibiscus sabdarifa*, *Hibiscus cannabinus*, *Amaranthus cruentus* and *Corchorus olifolius*. However, the sweet potato leaves contained only about one-third as much fatty acid as spinach (Nguyen *et al.* 2004).

Similarly, the amounts of minerals and trace elements we documented in sweet potato leaves from both Matsu and Hsinchu fell within the range of values reported for many other green leafy vegetables (Glew *et al.* 2009, 2010a, 2010b). Thus, sweet potato leaf represents a nutritionally significant source of many important minerals and trace elements that are essential for human health. Interestingly, sweet potatoes cultivated in Matsu produced leaves that contained 2.5-fold more iron, nearly 3-fold more iron, twice as much magnesium, and 50% more zinc and molybdenum than leaves from sweet potato grown on the main island in Hsinchu. The most likely reasons for these differences likely relates to soil conditions.

The sweet potato leaves from Matsu and the Taiwan mainland contained relatively large amounts of protein (13.7-17.1%) and their amino acid compositions, with the methionine and cysteine (score, 77-80%) (tryptophan was not determined), compared favorably to the WHO reference protein with regard to the other seven essential amino acids, including the tyrosine/phenylalanine pair (Table 4). Therefore, sweet potato leaves can contribute significant amounts of good quality protein to human diets. Of course, the relatively low sulfur amino acid content of sweet potato protein means that other protein sources that are rich in methionine and cysteine would be required to compensate for this deficiency.

It is interesting and perhaps somewhat counterintuitive that for most of classes of nutrients we studied, the leaves of sweet potato cultivated on the rocky island of Matsu outperformed those of sweet potato grown on the main island of Taiwan: the Matsu leaves had a qualitatively superior fatty acid profile (i.e., the ω -6/ ω -3 ratio), nearly 25% more protein, and a higher content of seven minerals and trace elements required by humans compared to the Hsinchu-grown leaves. Since sweet potato grows well under agriculturally stressful conditions, it would be interesting to repeat the present study using leaves of sweet potato cultivated in parts of the world, such as sub-Saharan Africa, where the soil and climatic conditions are often suboptimal, and where food supplies are commonly scarce. In fact, we intend to extend the present study to the leaves of sweet potato grown on the Jos Plateau of northcentral Nigeria in order to learn more about how differences in climate and geography affects the nutrient composition of sweet potato leaves.

The main limitation of the present study was that it provided no information regarding the bioavailability of the many different nutrients we found to be present in amounts found in the more widely consumed green leafy vegetables

such as spinach, cabbage and lettuce. Since antinutrients such as protease inhibitor, and divalent-cation chelators, such as phytates and tannins, can decrease the bioavailability of amino acids and minerals, respectively, future studies should assess the extent to which the full nutritional potential of these essential dietary factors are realized.

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