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Analytic Chemical Composition and Mineral Content of Yellow Velvetleaf (*Limnocharis flava* L. Buchenau)'s Edible Parts

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Abstract: This study was carried out to analyze the analytic chemical composition and minerals content of yellow velvetleaf (*Limnocharis flava* L. Buchenau) edible parts collected from waterways at Sebauh, Bintulu, Sarawak, Malaysia in early July 2008 using standard method of food analysis. The edible parts of *L. flava* high in total carbohydrate by difference (14.56±0.14%) and gross calorific value (343.26±9.75 kJ/100 g), but low in moisture (79.34±0.15%), ash (0.79±0.03%) and crude protein content (0.28±0.01%) in dry weight basis. However, the crude fat (1.22±0.01%) and crude fiber content (3.81±0.04%) were within the range of Malaysian leafy vegetables. The high concentration of K (4202.50±292.37 mg/100 g), Ca (770.87±105.26 mg/100 g, Cu (8.31±1.83 mg/100 g), Mg (228.10±15.26 mg/100 g) and Zn (0.66±0.05 mg/100 g) were found in edible parts of *L. flava*. The concentration of Na (107.72±17.15 mg/100 g) was much higher when compared to the recommended dietary allowances. Thus, the edible parts of *L. flava* provide good sources of minerals such as potassium, calcium, magnesium and copper. However, nutritive value analyzed should not be the exclusive criteria for judging the consumptive significance of the edible parts. Besides, others factors such as palatability should also be taken into consideration.

Key words: *Limnocharis flava*, edible parts, mineral elements, composition

INTRODUCTION

Yellow velvetleaf (*Limnocharis flava* L. Buchenau) was considered as an aquatic weed in paddy fields and also blocking the waterways that fed waters for irrigation. Despite of being undesired value to the agriculture, the floral clusters and its young leaves are locally used as raw and cooked. Local people use available natural resources as sources of food and to improve their socioeconomic (Tawan *et al*., 2007). About 100 species of the 225 vegetables in South East Asia are weeds or wild plants (Grubben *et al*., 1994). In Sarawak, 43 species belonging to 29 families of the aquatic plants that are utilized by the indigenous people and 19 species are locally used as the vegetable (Muta Harah *et al*., 2005). The vegetables are consumed because of their sweet taste, pleasant flavor and as a source of nutrients, vitamins and minerals (Grubben *et al*., 1994; Pampolona Roger, 2003). However, studies have shown that, the nutritive value of vegetables varies widely according to environmental factors, varietal differences, cultural practices, harvesting stage of plant, methods of storage, processing and preparation (Grubben *et al*., 1994; Guil-Guerrero *et al*., 1998; Flyman and Afolayan, 2008).

Yellow velvetleaf (*Limnocharis flava* L. Buchenau) or yellow bur-head and locally known by various names as paku rawan or jinjir or emparuk (Van den Bergh, 1994; Halimatul Saadiah, 2003; Samy *et al*., 2005; Muta Harah *et al*., 2005). It is an emergent plant in rice cultivated areas that may become noxious by over growing the areas (Soerjani *et al*., 1986; Mashoor, 1988; Karim *et al*., 2004). Young shoot comprising leaves and petioles and flower cluster (unopened inflorescence) are collected, consumed either raw or cooked (Edwards, 1980; Van den Bergh, 1994; Halimatul Saadiah, 2003; Samy *et al*., 2005; Muta Harah *et al*., 2005). In West Java and Thailand, it is commonly cultivated in fertile soil and harvested after 2-3 months before being marketed (Van den Bergh, 1994; Maisuthisakul, 2008). Other than serving as food, the nutritive values of *L. flava* were assessed with regards to ash, protein, fat, carbohydrate and calorific. In addition, *L. flava* from Thailand were

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examined for dietary fibers, elements such as iron, calcium, vitamin C, while phenolic and flavonoid content were also studied in relation to antiradical properties by Maisuthisakul (2008). Nutritive values of *L. flava* plants in Malaysia conducted by Samy *et al.* (2005) were limited to composition e.g., protein, carbohydrate, calorific value and lacking in information on mineral contents which is also important as an indicator on nutritive value of *L. flava.* Thus, the aims of this study was to complement available information provided by Samy *et al.* (2005) on the composition and to provide insights on the mineral contents of edible parts of *L. flava* from waterways of a wetland area of Sarawak, Malaysia in early July 2008.

MATERIALS AND METHODS

This study was carried out during the flowering season in early July of 2008 from waterways at Sebauh (N 03° 06' 34.3", E 113° 16' 15.2", 17 m above sea level), Bintulu, Sarawak, Malaysia.

Sample collection and preparation: Fresh samples of edible parts of young green shoots (leaves and petioles) and flower clusters of *L. flava* were collected and kept in an ice chest for transportation to the laboratory. In the laboratory, the samples were cleaned under running water and residual moisture evaporated at room temperature. The moisture content of the samples was determined at 60°C until constant weight was obtained following the method of Abuye (Hassan and Umar, 2006). The dried matter obtained was ground to a fine powder and stored in air tight containers prior to further analysis for ash, crude protein, crude fiber and crude fat (Umar *et al.*, 2007).

Analytic chemical composition analysis: Moisture, ash, crude protein, crude fat, crude fiber and total carbohydrate were determined according to AOAC (1990). Ash content was determined by incinerating at 500°C in muffle furnace for 6 h (method 930.05, AOAC, 1990).

Mineral analysis: The ash formed from the determination of ash analysis was placed in porcelain crucible. Few drops of distilled water were added and followed by 2 mL concentrated hydrochloric acid (HCl). Ten milliliters of 20% HNO_3 were added evaporated on the hotplate. The sample was filtered through Whatman filter paper No. 2 into 100 mL volumetric flask (method 922.02, AOAC, 1990). The mineral elements Na, K, Ca, Mg, Cu and Zn concentration were determined by atomic absorbance spectrophotometer (AA800 Perkin-Elmer, Germany) (method 975.03, AOAC, 1990).

The percentage of crude protein content was estimated by multiplying the sample percentage of nitrogen content obtained using 2200 Kjeltec Auto Distillation Foss Tecator, Sweden by a factor 6.25 (method 978.04, AOAC, 1990). The crude fat was extracted using 2055 Soxtec Avanti Manual System, Sweden and quantity of lipid was determined gravimetrically (method 930.09, AOAC, 1990). Crude fiber content was determined by the 2010 Fibertec System Foss Tecator, Sweden with repeated treatment of 1.25% sulphric acid (H_2SO_4) (w/v), followed by 1.25% potassium hydroxide (KOH) (w/v) and washing by water (method 930.10, AOAC, 1990). Total carbohydrate was calculated by difference from [100- (crude protein+crude fat+ash+crude fiber)] (AOAC, 1990). The gross calorific value in kJ/100 g dry matter was determined by automatic calorimeter (AC-350 Leco, USA) using benzoic acid pellets as a standard weight was obtained following the method of ASTM, (Wang and Littell, 1983).

RESULTS

Edible parts of *L. flava* comprising young shoots and inflorescences collected from residential waterways have a relatively high moisture content when compared to ash, crude protein, crude fat, crude fiber and total carbohydrate content (Table 1). The mineral composition and concentration in edible parts of *L. flava* is shown in Table 2. Edible parts of *L. flava* contain Potassium, Sodium, Calcium, Magnesium, Copper and Zinc in varying concentration with Potassium having the highest concentration. *Limnocharis flava* has a K/Na ratio approaching 40.

Table 1: Composition of edible parts of *Limnocharis flava* L. Buchenau

Parameters	Composition (% dry matter) of 100 g edible portion
Moisture*	79.34±0.15
Ash	0.79±0.03
Crude protein	0.28±0.01
Crude fat	1.22±0.01
Crude fiber	3.81±0.04
Total carbohydrate	14.56±0.14
Gross calorific value (kJ)	343.26±9.75

Each value is means of three replicates±Standard Deviation (SD). *Value expressed as % wet weight

Table 2: Mineral composition and concentration of edible parts of *Limnocharis flava* L. Buchenau

Elements	Concentration (mg/100 g) of edible portion
K	4202.50±292.37
Na	107.72±17.15
Ca	770.87±105.2
Mg	228.10±15.26
Cu	8.31±1.83
Zn	0.66±0.05
K/Na	39.61±4.91

Each value is means of three replicates±Standard Deviation (SD)

DISCUSSION

Analytic chemical analysis of a food is the nutritional composition of that food and it is the estimation of the nutritive value of human food in its chemical form (Alli Smith, 2009). The comparison on analytic chemical composition of *L. flava* edible parts with others leafy vegetables is shown in Table 3. This results obtained from analytic chemical analysis of *L. flava* edible parts establishes that this species be ranked as moisture rich plant due to their relatively high moisture content when compared with others component, since this plant is aquatic species. However, the moisture content of edible parts in this study was lower than that reported by Maisuthisakul *et al*. (2008) (94.7%) and on similar aquatic species, *Monochoria vaginalis* (88.6%) and *Ipomoea aquatica* (90.9%), respectively by Samy *et al*. (2005) and Rukayah (2002). In contrast, the moisture content in *I. aquatica* from similar environment at Nigeria waterways (Umar *et al*., 2007) was eight percent lower compared to *L. flava*. The moisture content was however within the range of 87.8-91.6% reported in some Malaysian leafy vegetables (Rukayah, 2002). The ash content (dry weight basis) of edible parts of *L. flava* was ten times less compared to both Thailand *L. flava* (Maisuthisakul *et al*., 2008) and Nigerian waterways *I. aquatica* (Umar *et al*., 2007). Compared to others leafy vegetable irrespective from terrestrial or aquatic environment, *L. flava* is low in ash (Rukayah, 2002) found in Malaysian leafy vegetables and *I. aquatica* edible parts grown in Malaysia (Samy *et al*., 2005).

The plant edible parts analyzed were low in crude protein compared to *L. flava* reported by Van den Bergh (1994), Samy *et al*. (2005) and Maisuthisakul *et al*. (2008) with value ranged of 1.0-11.3%. On the other hand, the protein content in *M. vaginalis* (1.0%) was 80% much higher than the value in *L. flava* as reported by Samy *et al*. (2005). In contrast, the crude protein content obtained in aquatic and terrestrial leafy vegetables (1.1-8.4%) was ten times higher than those in *L. flava* samples (Rukayah, 2002). The protein content of this plant appear to be low, could be as a result from pre-harvest period as a reported in *I. aquatica* leaves (Umar *et al*., 2007). The crude fat in *L. flava* edible parts observed was seven times lower when compared to the *L. flava* grown in Thailand reported by Maisuthisakul *et al*. (2008). This value compares favorably six times higher to aquatic plants such as *M. vaginalis* and *I. aquatica* (Rukayah, 2002; Samy *et al*., 2005) with the values of 0.2%, respectively. However, crude fat content is comparable with those some Malaysian leafy vegetables as reported by Rukayah (2002). In contrast, the crude fat in *L. flava* plants was lower to *I. aquatica* from similar environment in Nigeria with the value of 11.0% (Umar *et al*., 2007). The fiber content of *L. flava* in this study was very low when compared to the value reported by Maisuthisakul *et al*. (2008). *Limnocharis flava* edible parts were high in fiber content compared with Malaysian aquatic leafy vegetables but within the reported values of terrestrial leafy vegetables (Rukayah, 2002). A similar trend was reported on the estimated total carbohydrate with the values 3.6-6.7% in Malaysia aquatic leafy vegetables and

Table 3: Composition of yellow velvetleaf (*Limnocharis flava* L. Buchenau)'s edible parts compared with other leafy vegetables

Plant species, environment, geographical location	Composition (% dry matter) of edible portion						Calorific value (kJ)
	Moisture[a]	Ash	Crude protein	Crude fat	Crude fiber	Total carbohydrate	
Limnocharis flava (young shoots and inflorescence, waterways, Malaysia) present study*	79.34±0.15	0.79±0.03	0.28±0.01	1.22±0.01	3.81±0.04	14.56±0.14	343.26±9.75
L. flava (young shoots and inflorescence, environment type unknown, Malaysia)[1]	-	-	1.0	-	-	0.5	37.99
L. flava (leaves, environment type not mention, Thailand)[2]	94.7	11.4	11.3	8.4	52.6	55.4	1430.51
Monochoria. vaginalis (leaves, stem and flower, environment type unknown, Malaysia)[1]	88.6	-	1.0	0.2	-	3.8	69.96
Ipomoea aquatica (85% whole shoots, environment type unknown, Malaysia)[1, 5]	90.9	1.2	3.1	0.2	1.0	3.6	121.34
I. aquatica (leaves, waterways, Nigeria)[3]	72.83	10.83	6.30	11.0	17.67	54.20	1259.13
Momordica balsamina (leaves, environment type not mention, Nigeria)[4]	71.00	18.00	11.29	2.66	29.00	39.05	791.70
Aquatic leafy vegetable (leaves, environment type unknown, Malaysia)[5]	87.7-91.6	1.2-1.8	1.1-3.1	0.2-04	1.0-1.6	3.6-6.7	108-155
Terrestrial leafy vegetable (leaves, environment type unknown, Malaysia)[5]	72.0-93.1	0.9-2.5	2.3-8.4	0.2-1.8	0.6-4.7	0.6-18.4	75-381

*Values are means of three replicates±SD. -: No data available. [a]Value expressed as % wet weight. Source: [1]Samy *et al*. (2005), [2]Maisuthisakul *et al*. (2008), [3]Umar *et al*. (2007), [4]Hassan and Umar (2006) and [5]Rukayah (2002)

Table 4: Mineral composition of edible parts of yellow velvetleaf (*Limnocharis flava* (L.) Buchenau)'s edible parts compared with other leafy vegetables

Plant species, environment, geographical location	Concentration (mg/100 g) of edible portion						
	K	Na	Ca	Mg	Cu	Zn	K/Na
Limnocharis flava (young shoots and inflorescence, waterways, Malaysia) present study*	4202.50±292.37	107.72±17.15	770.87±105.2	228.10±15.26	8.31±1.83	0.66±0.05	39.61±4.91
L. flava (young shoots and inflorescence, environment type unknown, Malaysia)[1]	-	-	-	-	-	-	-
L. flava (leaves, environment type not mention, Thailand)[2]	-	-	52.6	-	-	-	-
Monochoria. vaginalis (leaves, stem and flower, environment type unknown, Malaysia)[1]	-	-	80	-	-	-	-
Ipomoea aquatica (85% whole shoots, environment type unknown, Malaysia)[1, 5]	78	65	88	37.0	0.1	0.5	1.2
I. aquatica (leaves, waterways, Nigeria)[3]	5458.33	135.00	416.70	301.64	0.36	2.47	40.43
Momordica balsamina (leaves, environment type not mention, Nigeria)[4]	1320.00	122.49	941	220	5.44	3.18	1320.00
Aquatic leafy vegetable (leaves, environment type unknown, Malaysia)[5]	78-391	21-65	88-171	-	-	-	1.2-18.6
Terrestrial leafy vegetable (leaves, environment type unknown, Malaysia)[5]	199-708	3-33	53-290	-	-	-	15.48-209.67

*Values are means of six replicates±SD. -: No data available. Source: [1]Samy *et al.* (2005), [2]Maisuthisakul *et al.* (2008), [3]Umar *et al.* (2007), [4]Hassan and Umar (2006), and [5]Rukayah (2002)

0.6-18.4% found in Malaysia terrestrial leafy vegetable (Rukayah, 2002). The calorific values of most vegetables are low within range 125-209 kJ/100 g (Umar *et al.*, 2007). In edible parts of *L. flava* substantial (343.26±9.75 kJ/100 g) content was observed which is about nine times higher than 37.99 kJ/100 g as reported by Samy *et al.* (2005) and other edible aquatic species *M. vaginalis* (69.96 kJ/100 g) and *I. aquatica* (121.34 kJ/100 g) consumed by Malaysians (Rukayah, 2002; Samy *et al.*, 2005). This calorific value is much lower than (1430.51 kJ/100 g) reported by Maisuthisakul *et al.* (2008).

The mineral composition in edible parts of *L. flava* were compared with other leafy vegetables (Table 4). The mineral concentration in edible parts of *L. flava* shows that potassium is relatively high when compared with other elements. Fresh vegetables are one of the major dietary sources of potassium (K) (Insel *et al.*, 2002). K content (dry weight basis) in this plant was six times higher than those reported in Malaysian leafy vegetables with the values ranged 78-708 mg/100 g (Rukayah, 2002; Samy *et al.*, 2005). The value was similar to those of *I. aquatica* grown in Nigeria (5458.33 mg/100 g) as reported by Umar *et al.* (2007). A similar trend was also observed for sodium (Na) which is slightly lower than Nigerian *I. aquatica* (135.0 mg/100 g) but much higher when compared with sodium in others leafy vegetables available in Malaysia (13-171 mg/100 g) (Rukayah, 2002). Hassan and Umar (2006) noted K/Na in diet is an important factor in prevention of hypertension and arteriosclerosis, with K depresses and Na enhances blood pressure. The ratio of K/Na (39.61±4.91) in edible parts of *L. flava* was similar to *I. aquatica* (40.43) from Nigeria (Umar *et al.*, 2007).

Limnocharis flava has about six times higher in calcium (Ca) content compared to *L. flava* with the value of 52.6 mg/100 g grown in Thailand (Maisuthisakul *et al.*, 2008); others Malaysian leafy vegetables with the values ranged from 53-88 mg/100 g (Paisooksantivatana, 1994; Rukayah, 2002; Samy *et al.*, 2005). The concentration of this element was also higher, about 100% more than that in Nigerian leafy vegetables as reported by Aletor *et al.* (2002) with the values of 524-633 mg/100 g and found in *I. aquatica* (416.70 mg/100 g) by Umar *et al.* (2007), while lower in concentration compared to those in balsam apple leaves (941 mg/100 g) (Hassan and Umar, 2006). This suggests the edible parts of *L. flava* provide a good source of Ca. Magnesium (Mg) obtained in *L. flava* was far greater than those recorded in Malaysian *I. aquatica* leaves with the value of 37 mg/100 g (Samy *et al.*, 2005). Mg is responsible to the formation of chlorophyll or deep green color in vegetables (Insel *et al.*, 2002).

Copper (Cu) is another trace element, essential in human body where it exists as an integral part of copper proteins ceruplasmin, the enzyme that catalyzes the oxidation of ion iron (Insel *et al.*, 2002). The edible parts of *L. flava* have high concentration of this element. With respect to Cu, only 0.10 mg/100 g was found in cultivated *I. aquatica* from Malaysia and 0.36 mg/100 g in Nigerian *I. aquatica*. Comparatively the Cu content is low in *Momordica balsamina* (5.44 mg/100 g) (Samy *et al.*, 2005; Hassan and Umar, 2006; Umar *et al.*, 2007). Zinc (Zn) element in *L. flava* from this study was almost similar to *I. aquatica* consumed by Malaysians with the value of 0.50 mg/100 g (Samy *et al.*, 2005). However, the Zn concentration in *I. aquatica* grown in waterways, Nigeria was many time higher. Based on the results obtained from the present study in comparison to other studies of aquatic plants (Hassan and Umar, 2006; Umar *et al*., 2007) at various geographical locations, *L. flava* has similar trend in mineral concentration categorically as K>Ca>Mg>Na>Zn.

CONCLUSION

Limnocharis flava is typically collected by the local population and encountered in fresh produce markets. It is consumed raw or as cooked vegetable. The results obtained from this study showed that the edible parts of *L. flava* is low in moisture and crude protein content but having comparable crude fiber and crude fat content to other Malaysians leafy vegetables. The edible parts of *L. flava* have sweet taste, pleasant flavor and also provide good sources for the minerals (particularly K, Ca, Mg and Cu). The composition and minerals content is comparable to the well-known leafy vegetables such as *I. aquatica*, *M. vaginalis* and *Momordica balsamina* that are commonly consumed by the people in Asia. The nutritive value analyzed in this present study alone should not be the exclusive criteria for judging the consumptive significance of the plant. Analysis on phosphorus, iron, manganese, anti-nutritional and toxicological can be recommended to evaluate further on the plant nutritive properties. Besides, others factors such as palatability should also be taken into consideration.

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REFERENCES

Aletor, O., A.A. Oshodi and K. Ipinmoroti, 2002. Chemical composition of common leafy vegetables and functional properties of their leaf protein concentrates. Food Chem., 78: 63-68.

Alli Smith, Y.R., 2009. Determination of chemical composition of *Senna-siamea* (Cassia Leaves). Pak. J. Nutr., 8: 119-121.

AOAC, 1990. Official Methods of Analysis. 15th Edn., Association of Official Analytical Chemists, Washington DC. USA., ISBN 0-935584-42-0.

Edwards, P., 1980. Food Potential of Aquatic Macrophytes. 1st Edn., International Center for Living Aquatic Resources Management, Metro Manila, Philippines.

Flyman, M.V. and A.J. Afolayan, 2008. Effect of plant maturity on the mineral content of the leaves of *Momordica balsamina* L. and *Vigna unguiculata* subp. *sesquipedalis* (L.) Verdc. J. Food Qual., 31: 661-671.

Grubben, G.J.H., J.S. Siemonsma and P. Kasem, 1994. Introduction. In: Plant Resources of South-East Asia 8: Vegetables, Siemonsma, J.S. and P. Kasem (Eds.). PROSEA, Bogor, Indonesia.

Guil-Guerrero, J.L., A. Gimenez-Gimenez, I. Rodriguez-Garcia and M.E. Torija-Isasa, 1998. Nutritional composition of *Sonchus* species (*S. asper* L., *S. oleraceus* L. and *S. tenerrimus* L.). J. Sci. Food Agric., 76: 628-632.

Halimatul Saadiah, A.S., 2003. Sayur-sayuran Semenanjung Malaysia. 1st Edn., Dewan Bahasa dan Pustaka, Kuala Lumpur.

Hassan, L.G. and K.J. Umar, 2006. Nutritional value of balsam apple (*Momordica balsamina* L.) leaves. Pak. J. Nutr., 5: 522-529.

Insel, P., R.E. Turner and D. Ross, 2002. Nutrition. 1st Edn., Jones and Bartlett, USA.

Karim, S.M.R., B.M. Azmi and B.S. Ismail, 2004. Weed problems and their management in rice fields of Malaysia: An overview. Weed Biol. Manage., 4: 177-186.

Maisuthisakul, P., S. Pasuk and P. Rithiruangdej, 2008. Relationship between antioxidant properties and chemical composition of some Thai plants. J. Food Comp. Anal., 21: 229-240.

Mashoor, M., 1988. Aquatic weeds in rice waterways. Proceeding of the National Seminar and Workshop on Rice Weed Management, Jun. 7-9, Penang, Malaysia, pp: 69-78.

Muta Harah, Z., B. Japar Sidik, A. Raesah, C. Maini and A. Suzalina, 2005. Aquatic macrophytes in natural and man made water bodies. Bio-Sci. Res. Bull., 21: 27-36.

Paisooksantivatana, Y., 1994. Neptunia Oleraceae Loureiro. In: Plant Resources of South-East Asia 8: Vegetables, Siemonsma, J.S. and P. Kasem (Eds.). PROSEA, Bogor, Indonesia, pp: 217-218.

Pampolona Roger, G.D., 2003. Dimensions of Health Physical: The Healing Power of Foods. 1st Edn., IADP, Spain.

Rukayah, A., 2002. Ulam Dan Sayuran Tempatan Semenanjung Malaysia. 2nd Edn., Dewan Bahasa dan Pustaka, Kuala Lumpur.

Samy, J., M. Sugumaran and L.L.W. Kate, 2005. Herbs of Malaysia: An Introduction to the Medicinal, Culinary, Aromatic and Cosmetic Use of Herbs. 1st Edn., Shah Alam, Selangor.

Soerjani, M., A.J.G.H. Koestermans and T. Gembong, 1986. Weeds of Rice in Indonesia. Balai Pustaka, Jakarta.

Tawan, C.S., B.M. Abdul Gani, I.B. Ipor and J. Dawen, 2007. Medicinal plants of the Iban community in Sabal District, Sarawak. Proceedings of Conference on Natural Resources in the Tropics: Development and Commercialization of Tropical Natural Resources, 2007, Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, Kota Samarahan, pp: 401-408.

Umar, K.J., L.G. Hassan, S.M. Dangoggo and M.J. Ladan, 2007. Nutritional composition of water spinach (*Ipomoea aquatica* Forsk.) leaves. J. Applied Sci., 7: 803-809.

Van den Bergh, M.H., 1994. *Limnocharis flava* L. Buchenau. In: Plant Resources of South-East Asia 8: Vegetables, Siemonsma, J.S. and P. Kasem (Eds.). PROSEA, Bogor, Indonesia, pp: 192-194.

Wang, S.C. and R.C. Littell, 1983. Phenotypic variation in calorific value of melaleuca materials from South Florida. Econ. Bot., 37: 292-298.