

Phytochemicals, Nutritional Values and Antioxidant Activity From the Roots of *Ipomoea batatas* L. (Sweet Potato)

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Abstract

This research concerns with the investigation of phytochemical constituents, nutritional values, total phenolic content and antioxidant activity from *Ipomoea batatas* roots. The phytochemical analyses revealed the presence of alkaloids, α -amino acids, carbohydrates, flavonoids, glycosides, phenolic compounds, reducing sugars, saponins, starch and tannins in selected sample. Nutritional values determined by AOAC method provided moisture, fat, fiber, protein, carbohydrates, ash contents and energy value (kcal/100g) in selected sample. The total phenolic content of crude extract in *Ipomoea batatas* root was determined by FCR method, used standard gallic acid and the results were expressed as microgram of gallic acid equivalent per milligram of crude extract (μg GAE/mg). The antioxidant activity was determined by the DPPH radical scavenging assay. The antioxidant activity of ethanol extract in *Ipomoea batatas* (IC₅₀ value: 36.92 $\mu\text{g}/\text{mL}$) was found to be higher than water extract (IC₅₀ value: 54.45 $\mu\text{g}/\text{mL}$). Therefore, *Ipomoea batatas* roots may be used as phytochemicals, human nutrition and powerful antioxidant.

Keywords: *Ipomoea batatas* L., phytochemicals, nutritional values, total phenolic content, antioxidant activity

1. Introduction

Sweet potato, *Ipomoea batatas* L. from the family of Convolvulaceae, is widely grown in tropical, subtropical and warm temperate regions (Scott., 1992). The plant is widely cultivated and consumed throughout the world. It is an herbaceous perennial vine with alternate heart-shaped, lobed leaves and medium-sized flowers. The root is edible and is often long and tapered. The skin may be red, purple or brown and white in color. The flesh may be white, yellow, orange or purple. The leaves and shoots are eaten as vegetables (Zhao *et al.*, 2005). In comparison to other major staple food crops, sweet potato has the following positive attributes: wide production geography, adaptability to marginal conditions, short production cycle, high nutritional value and taste and texture. It is commonly used as food, to feed livestock and as a medicinal plant. Moreover, it can be used as vegetable, either with simple tempering or with little curry. Industrially, sweet potatoes have been used in the manufacture of textiles, cosmetics, paper and adhesives (Truong *et al.*, 2010).

Sweet potato is considered to be one of the highly nutritious foods. Majority of the people enjoy the wonderful flavor and health benefits of sweet potato. Sweet potato roots are a good source of carbohydrates, an excellent source of vitamin A (in the form of beta-carotene), a very good source of vitamin C and manganese, a good source of copper, dietary fiber, vitamin B₆, B₁, B₂, phosphorus, potassium and iron. Both these vitamins are effective antioxidants that actually work in our body, removing free radicals. Root vegetable is low in calories and comprises no fat. Besides, pulp obtained from crushed raw potatoes, mixed with honey, can serve as excellent skin and face packs (Cardenas *et al.*, 1993).

The sweet potato roots and skin contain high levels of polyphenols such as anthocyanins and phenolic acids (eg, caffeic acid). Caffeoylquinic acid derivatives like chlorogenic, dicaffeoylquinic and tricaffeoylquinic acids are found in the roots that protect them from fungal diseases and have potential cancer chemoprotective effects (Konczak *et al.*, 2003). Sweet potato roots and plants are powerful antioxidants. The plant's antioxidant activity is associated with its alpha-tocopherol content, which is the most common form of vitamin E. The major phenolic components in crude extract of sweet potatoes showed strong antioxidant activity in a linoleic acid-aqueous system (Hayase *et al.*, 1984).

The present work focuses on phytochemicals investigation, nutritional values, total phenolic content and antioxidant activity in *Ipomoea batatas* roots. Our results may provide scientific evidence for the nutritional food as a therapeutic potential.

Scientific Classification of *Ipomoea batatas* L.

Kingdom	: Plantae
Family	: Convolvulaceae
Botanical name	: <i>Ipomoea batatas</i> L.
Common name	: Sweet potato
Myanmar name	: Kan-zon-u
Part used	: Root

The photographs of the plants and roots of *Ipomoea batatas* L. (Sweet potatoes) are shown in Figure 1.

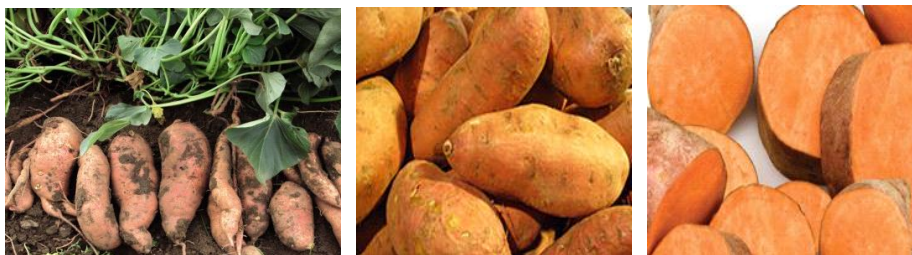


Figure 1 Plants and roots of *Ipomoea batatas* L. (Sweet potatoes)

2. Materials and Methods

The roots of *Ipomoea batatas* (Sweet potato) were collected from Myingyan Township, Mandalay Division, in 2016. The sample was identified at the Botany Department, Myingyan Degree College. The collected samples were cleaned, sliced into small pieces and dried under shade. The dried materials were then crushed in mechanical grinder in order to make fine powder which was stored in air tight container at room temperature for experimental use.

2.1 Phytochemical Screening of *Ipomoea batatas* Roots

Qualitative phytochemical investigations were performed to analyze the presence or absence of various chemical constituents such as alkaloids, α -amino acids, carbohydrates, flavonoids, glycosides, phenolic compounds, reducing sugars, saponins, starch and tannins using the standard procedures as described by Marini-Bettolo *et al.*, 1981; M-Tin Wa, 1972.

2.2 Preparation of Crude Extracts in Selected Sample

Dried powdered sample (each 10 g) was separately extracted with 100 mL of ethanol and distilled water at their respective boiling point ranges for 3-4 h by using hot extraction. Each extract was filtered through Whatman No.1 filter paper and the filtrate was concentrated under reduced pressure at 40°C. The crude extracts were kept at 4°C in storage vials for experimental use.

2.3 Determination of Nutritional Values in *Ipomoea batatas* Roots by AOAC Method

Nutritional values such as moisture content, fat content, fiber content, protein content, ash content, carbohydrate content and energy value of the selected sample were determined by AOAC method (AOAC, 2002) in Food Industries Development Supporting Laboratory (FIDSL). The moisture content was determined by the oven drying method. The fat content was determined by Soxhlet extraction method using petroleum ether (b. p 60-80°C) run for 9 h. The fiber content was determined by

acid-base digestion method using hot sulphuric acid solution (1.25 % v/v) and sodium hydroxide solution (1.25 % w/v). The nitrogen content was determined by micro-Kjeldahl's method and protein content was calculated by multiplying percent nitrogen by protein-nitrogen conversion factor 6.25. The ash content was determined by placing sample in preweighed crucible and placed in muffle furnace at 500°C for 6 h. Carbohydrate percentage was calculated by the following equation:

$$\text{Carbohydrate (\%)} = 100 - \% (\text{ash} + \text{fat} + \text{fiber} + \text{moisture} + \text{protein})$$

The energy value of selected sample was calculated by the following equation:

$$\text{Energy value (kcal/100 g)} = (4 \times \text{protein}) + (4 \times \text{carbohydrate}) + (9 \times \text{fat})$$

2.4 Determination of Total Phenolic Content in Crude Extracts by FCR Method

The total phenolic content (TPC) in each crude extract was determined spectrophotometrically (Shimazu UV-1800) according to Folin-Ciocalteu method as described by Song *et al.*, 2010. Determination of total phenolic content was performed at Department of Chemistry, West Yangon University, Yangon Division. Each extract (1 mg) was made up to 10 mL of distilled water. Each extract solution (0.5 mL of sample and 0.5 mL methanol) was mixed thoroughly with 5 mL of FCR solution (FCR : H₂O, 1:10 v/v) and incubated for 30 min at 37°C. 4 mL of 1 M sodium carbonate solution was added to each tube and the tubes were kept at room temperature for 15 min. The same procedure was repeated for different concentrations of standard gallic acid solution (100, 50, 25, 12.5 and 6.25 µg/mL). The absorbance of reaction mixture was measured at λ_{max} 765 nm using spectrophotometer against blank. The samples were prepared in triplicate for each analysis and the mean value of absorbance was obtained. The concentration of gallic acid equivalent (GAE) of each extract was calculated by using the linear regression equation from the standard curve of gallic acid. Total phenolic content was estimated as microgram gallic acid equivalents per milligram of crude extracts (µg GAE/mg).

2.5 Determination of Antioxidant Activity of Crude Extracts in Selected Sample by DPPH Free Radical Scavenging Assay

The antioxidant activity of crude extracts from *Ipomoea batatas* roots was determined by spectrophotometrically (Shimazu UV-1800) according to DPPH free radical scavenging assay (Marinova and Batchvarov, 2011). Determination of antioxidant activity was performed at Department of Chemistry, West Yangon University, Yangon Division. The control solution was prepared by mixing 1.5 mL of 0.002% DPPH solution and 1.5 mL of ethanol in the brown bottle. The blank solution was prepared by mixing 1.5 mL of sample solution and 1.5 mL of ethanol in brown bottle. The sample solution was also prepared by mixing 1.5 mL of 0.002% DPPH solution and 1.5 mL of test sample solution. These bottles were incubated at room temperature and were shaken on shaker for 30 min. After 30 min, the absorbance of different concentrations in tested samples was measured at λ_{max} 517 nm using spectrophotometer. Absorbance measurements were done in three times for each concentration and the mean value was obtained. The percentage of radical scavenging activity (% RSA) was calculated by the following equation.

$$\% \text{ RSA} = [A_{\text{DPPH}} - (A_{\text{Sample}} - A_{\text{Blank}}) / A_{\text{DPPH}}] \times 100$$

where, RSA = % radical scavenging activity of test samples

A_{DPPH} = absorbance of DPPH in ethanol solution ;

A_{Sample} = absorbance of sample with DPPH solution

A_{Blank} = absorbance of sample in ethanol solution

The antioxidant power (IC₅₀) is expressed as the test substances concentration (µg/mL) that results in a 50% oxidative inhibition of the substance. IC₅₀ values were calculated by linear regressive excel program.

3. Results and Discussion

The crude extracts such as ethanol and water in *Ipomoea batatas* roots were prepared to investigate phytochemical constituents, nutritional values, the total phenolic content and antioxidant activity. Phytochemical screening in crude extracts of *Ipomoea batatas* roots was carried out to identify the secondary metabolites. The phytochemical analysis revealed that alkaloids, α-amino acids, carbohydrates, flavonoids, glycosides, phenolic compounds, reducing sugars, saponins, starch and tannins were present in selected *Ipomoea batatas* roots. Phytochemical analysis of crude extracts revealed the presence of different active phytoconstituents in ethanol and water extracts. It has recognized that alkaloids, flavonoids and phenolic compounds show antioxidant activities for their effects on human nutrition and then health benefits are considerable (Kumpulainen *et al.*, 1999).

3.1 Nutritional Values of *Ipomoea batatas* Roots

People and other living organisms need certain substances of nutrient to survive. Nutritional values and some physicochemical properties such as moisture, fat, fiber, protein, ash, carbohydrate and energy values in the selected sample were analyzed and the results are shown in Table 1 and Figures 2 and 3.

Ipomoea batatas roots contain moisture (75.0 %), fat (0.05 %), fiber (3.0 %), protein (1.6%), carbohydrate (20.0 %), ash (1.08 %) and energy value (86.85 kcal/100g) respectively. The highest moisture percent of the sample indicates a possible reduction in sample shelf life. Low fat foods are known to reduce cholesterol. High fiber content in food causes intestinal irritation and lower bioavailability. The protein has many medicinal properties. High quantity source of carbohydrates and dietary fibers are present for human nutrition. The ash percent is a measure of the quality of food (Ogbe and Affiku, 2012). According to the results, the presence of the important nutrients like fat, fiber, protein, carbohydrate and physical properties like moisture and ash in the selected sample may be used as a nutritionally valuable for daily use and healthy ingredient to treat many diseases.

Table 1 Results for Nutritional Values of *Ipomoea batatas* Roots

No.	Nutrient	Content (%)
1	Moisture	75.0
2	Fat	0.05
3	Fiber	3.0
4	Protein	1.6
5	Carbohydrate	20.0
6	Ash	1.08
7	Energy value (kcal/100g)	86.85

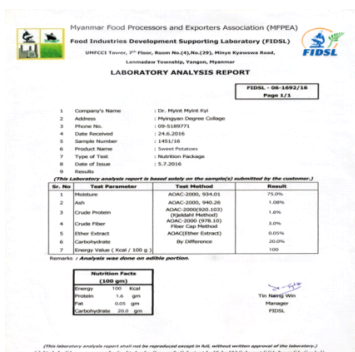


Figure 2 Laboratory analysis report for sweet potatoes

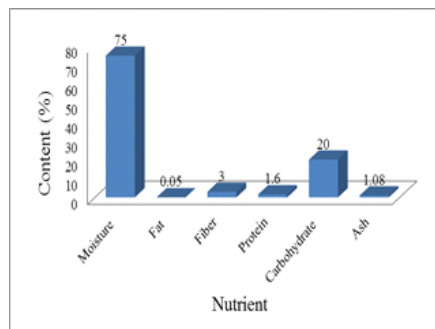


Figure 3 Nutritional values of *I. batatas* roots

3.2 Total Phenolic Contents of Crude Extracts in *Ipomoea batatas* Roots

In this study, the total phenolic contents of crude extracts in sweet potatoes were estimated by FCR method. Phenols reacts with an oxidizing agent phosphomolybdate in F-C reagent under alkaline conditions resulting the formation of blue coloured complex, the molybdenum blue which is measured at 765 nm colorimetrically. Gallic acid was used to construct standard calibration curve for total phenolic content estimation as shown in Table 2 and Figure 4.

From the results in Table 3 and Figure 5, the total phenolic content (μg GAE/mg) of ethanol and watery extracts in sweet potatoes were 57.29 ± 0.22 and $53.89 \pm 0.18 \mu\text{g}$ GAE/mg, respectively. From these results, it was found that ethanol extract showed higher total phenolic content than watery extract in selected samples. So, ethanol extract is more effective than watery extract. The greater the total phenolic content showed the higher antioxidant activity.

Table 2 Absorbance of Standard Gallic Acid Solution at 765 nm

Concentration ($\mu\text{g/mL}$)	6.25	12.50	25.00	50.00	100.00
Absorbance	0.152	0.270	0.449	0.824	1.540

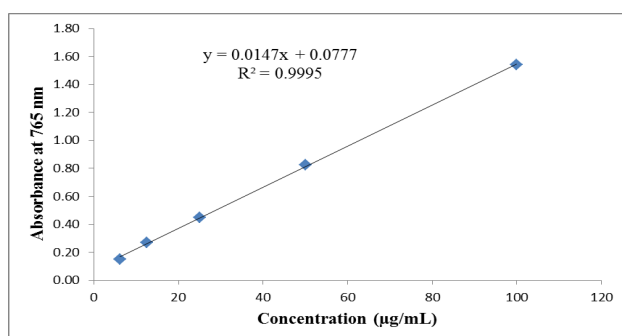


Figure 4 Gallic acid standard curve at 765 nm

Table 3 Total Phenolic Content of Crude Extracts in *I. batatas* Roots (Sweet potatoes)

No.	Extracts	TPC (μg GAE/mg \pm SD)
1	Ethanol (SP)	57.29 ± 0.22
2	Water (SP)	53.89 ± 0.18

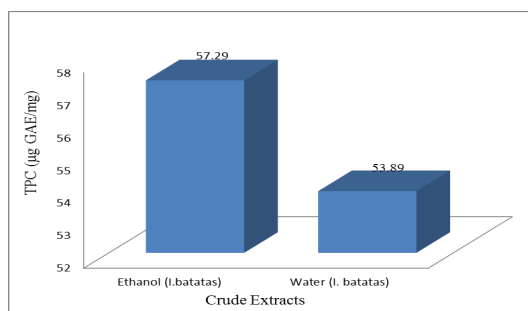


Figure 5 A bar graph of total phenolic content of crude extracts in *I. batatas* roots

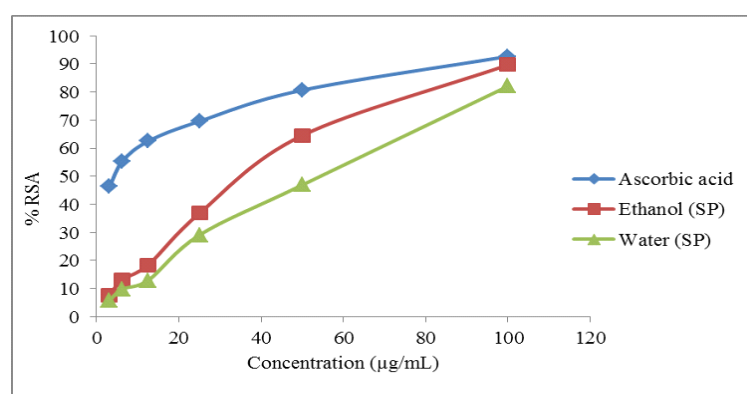
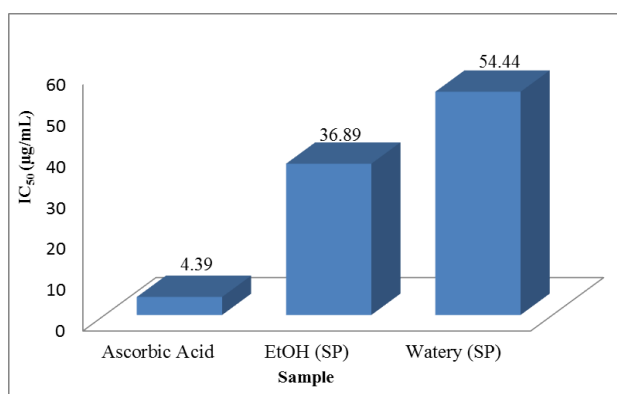
3.3 Antioxidant Activity of Crude Extracts in *Ipomoea batatas* Roots (Sweet potatoes)

DPPH (2, 2-diphenyl-1-picrylhydrazyl) method is the most widely reported method for screening of antioxidant activity on many plant drugs. This method is based on the reduction of coloured free radical DPPH in ethanol solution by different concentration of the samples. The antioxidant activity was expressed as 50 % oxidative inhibitory concentration (IC_{50}). In present study, six different concentrations of each crude extract in 95 % ethanol were measured at λ_{max} 517 nm according to the spectrophotometric method. Ascorbic acid was used as standard and ethanol without crude extract was employed as control. The results of percent oxidative inhibition values of crude extracts are summarized in Table 4 and Figures 6 and 7.

From the experimental results, percent RSA values of ethanol and water extracts (100 µg/mL) were found to be 89.66 ± 0.28 % and 82.05 ± 0.32 % in *I. batatas* roots, respectively. Therefore, these crude extracts in *I. batatas* roots had significant antioxidant activities and the concentration were increased, the absorbance values were decreased, i.e increase in radical scavenging activity of crude extracts usually expressed in term of % inhibition. From the average value of % inhibition, IC_{50} (50 % inhibition concentration) values in µg/mL were calculated by linear regressive excel program. The IC_{50} values of crude extracts (ethanol and watery) were found to be 36.89 µg/mL and 54.44 µg/mL in selected sample. Among the crude extracts, the lower IC_{50} showed the higher free radical scavenging activity, ethanol extract in *I. batatas* roots was found to be more potent than water extract in free radical scavenging activity. However, it was observed that these extracts have the moderate antioxidant activity than standard ascorbic acid ($IC_{50} = 4.39$ µg/mL) under condition. The antioxidant potential of crude extracts may be due to the difference in chemical structure of their phenolic and flavonoid compounds.

Table 4 Percentage of Radical Scavenging Activity of Standard Ascorbic Acid and Crude Extracts in *I. batatas* Roots (Sweet potatoes)

Samples	% RSA \pm SD of different concentrations ($\mu\text{g/mL}$)						IC ₅₀ ($\mu\text{g/mL}$)
	3.125	6.25	12.50	25.00	50.00	100.00	
Ascorbic Acid	46.32 \pm 0.11	55.34 \pm 0.13	62.46 \pm 0.11	69.58 \pm 0.21	80.64 \pm 0.16	92.84 \pm 0.11	4.39
Ethanol (SP)	7.73 \pm 0.26	13.15 \pm 0.23	18.41 \pm 0.21	36.83 \pm 0.21	64.52 \pm 0.29	89.66 \pm 0.28	36.89
Water (SP)	5.88 \pm 0.28	9.82 \pm 0.21	12.91 \pm 0.31	29.08 \pm 0.38	46.88 \pm 0.43	82.05 \pm 0.32	54.44

Figure 6 A plot of % RSA vs concentration ($\mu\text{g/mL}$) of standard ascorbic acid and crude extracts in *I. batatas* rootsFigure 7 A bar graph of IC₅₀ value of ascorbic acid and crude extracts in *I. batatas* roots

4. Conclusion

From the overall assessment of the chemical investigation in *Ipomoea batatas* roots, the following inferences could be deduced.

Phytochemicals such as alkaloids, α -amino acids, carbohydrates, flavonoids, glycosides, phenolic compounds, reducing sugars, saponins, starch and tannins were found to be present in selected sample. Nutritional values of *I. batatas* roots by AOAC method were found to be 75.0 % of moisture, 0.05 % of fat, 3.0 % of fiber, 1.6

% of protein, 20.0 % of carbohydrate, 1.08 % of ash and 86.85 kcal/100g of energy value, based on wet sample.

Total phenolic content of ethanol and water extracts in *I. batatas* roots were found to be 57.29 ± 0.22 and 53.89 ± 0.18 $\mu\text{g GAE/mg}$. Percent radical scavenging activity of ethanol and water extracts in selected sample were determined with six different concentrations (3.125, 6.25, 12.50, 25.00, 50.00 and 100.00) $\mu\text{g/mL}$ by DPPH radical scavenging assay. IC_{50} value of ethanol and water extracts in sample were found to be 36.89 $\mu\text{g/mL}$ and 54.44 $\mu\text{g/mL}$. Therefore, ethanol extract in *I. batatas* roots showed more potent antioxidant activity than water extract. The findings from the research work may contribute to the source of nutrients, energy values, potential source of natural antioxidant, phytoconstituents which could be benefit for human health.

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References

- AOAC, (2002). "Official Methods of Analysis". *Association of Official Analytical Chemist, International Food Research Journal*, 17, 426-432
- Cardenas, H., Kalinowski, J., Huaman, Z. and Scott, G. (1993). "Nutritional evaluation of sweet potato cultivars *Ipomoea batatas* (L.) Lam used in bread as partial substitute of wheat flour". *Archive Latinoamericanos de Nutricion*, 43, 304-309
- Hayase, F. and Kato, H. (1984). "Antioxidative components of sweet potatoes". *J. Nutritional Science and Vitaminology*, 30: 37-46
- Kumpulainen, J. T. and J. T. Salonen. (1999). "Natural Antioxidants and Anticarcinogens in Nutrition, Health and Disease". *The Royal Society of Chemistry*, UK, pp. 178-187
- Ogbe, A.O. and Affiku, J. P. (2012). "Proximate Study, Mineral and Anti-Nutrient Composition of *Moringa oleifera* Leaves Harvested from Labia, Nigeria: Potential Benefits in Poultry Nutrition and Health". *J. Sci.*, 1, 301-305
- Marini-Bettolo, G. B., M. Nicolettic and M. Patamia. (1981). "Plant Screening by Chemical and Chromatographic Procedure Under Field Conditions". *J. Chromato.*, 45, 121-123
- Marinova, G. and V. Batchvarov. (2011). "Evaluation of the Method for Determination of the Free Radical Scavenging Activity by DPPH". *Bulg. J. Agric. Sci.*, 17, 11-24
- M-Tin Wa. (1972). "Phytochemical Screening Methods and Procedures". *Phytochemical Bulletin of Botanical Society of America*, 5 (3), 4-10
- Scott, G. J., Wiersema, S. and Ferguson, P. I. (1992). "Product Development for Roots and Tuber Crops". *Asia International Potato Center (CIP)*, Lima, Pegu, vol. 1, pp. 3-20
- Song, F. L., R. Y. Gan, Y. Zhang, Q. Xiao, L. Kuang and H. B. Li. (2010). "Total Phenolic Contents and Antioxidant Capacities of Selected Chinese Medicinal Plants". *Int. J. Mol. Sci.*, 11, 2367-2372
- Truong, V. and Avul, R. Y. (2010). "Sweet potato purees and powders for functional food ingredients". *Sweet potato: Post Harvest Aspects in Food. Nova Science Publishers Inc*, New York, USA, pp. 117-161
- Zhao, R., Li, Q., Long, L., Yang, R. and Gao, D. (2007). "Antidiabetic activity of flavone from *Ipomoea batatas* leaf in non-insulin dependent diabetic rats". *International J Food Science and Technology*, 42: 80-85