

## Nutritional and Nutraceutical Components of Commercial Eggplant Types Grown in Sinaloa, Mexico

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### Abstract

The nutrimental composition and main nutraceutical components were determined in Chinese, Philippine, American, Hindu and Thai eggplant (*Solanum melongena* L.) types grown in Sinaloa, Mexico. Thai type showed the highest amount of protein (0.90%), crude (1.54%) and dietary (3.93%) fibre and the highest concentrations of total soluble phenolics (2049 mgCAE 100g<sup>-1</sup>) and chlorogenic acid (1700 mg 100g<sup>-1</sup>). Hindu type obtained the highest content of the minerals potassium (191.19 mg 100g<sup>-1</sup>), calcium (59.63 mg 100g<sup>-1</sup>), phosphorus (33.52 mg 100g<sup>-1</sup>), magnesium (28.96 mg 100g<sup>-1</sup>), manganese (0.44 mg 100g<sup>-1</sup>), zinc (0.78 mg 100g<sup>-1</sup>), in addition this eggplant type showed the highest levels of ascorbic acid (22 mg 100g<sup>-1</sup>). Philippine type showed the highest concentration in anthocyanins (161.10 mgC<sub>3</sub>GE 100g<sup>-1</sup>) and the highest levels of radical scavenging activity in DPPH (92.50% of inhibition) and ORAC (538.90 μmolTE g<sup>-1</sup>). Nutrient components with functional properties like biologically essential minerals, dietary fibre, ascorbic acid (vitamin C) and soluble phenols were found in higher amounts in the five eggplant types analyzed, as compared with reports from other parts in the world available in the literature.

**Keywords:** antioxidant capacity, ascorbic acid (Vitamin C), chlorogenic acid, mineral content, proximate composition, *Solanum melongena* L., total soluble phenols

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### Introduction

The eggplant (*Solanum melongena* L.) also known as aubergine, guinea squash or brinjal, is an economically important vegetable crop in the tropics and subtropics. Eggplant cultivars produce fruits with a wide diversity of shapes, sizes and colours (Kashyap *et al.*, 2003; Kantharajah and Golegaonkar, 2004). Sinaloa, in northwest Mexico, is the major eggplant producer in the country, growing an average of eight eggplant types, out of which American type is the most widely grown. Eggplants have an important nutritional value due to its composition, which includes minerals like potassium, calcium, sodium and iron (Mohamed *et al.*, 2003; Raigón *et al.*, 2008) as well as dietary fibre (USDA, 2014; Sanchez-Castillo *et al.*, 1999). Fruits and vegetables are the main dietary sources of phenolic compounds for humans,

with phenolic acids and flavonoids being the most abundant (Scalbert and Williamson, 2000; Manach *et al.*, 2004). Eggplant fruits have shown high hydrophilic oxygen radical absorbance capacity (ORAC) (Cao *et al.*, 1996), which has been correlated to phenolic compounds presence, including delphinidin as a major component in peel (Wu *et al.*, 2006; Koponen *et al.*, 2007) and chlorogenic acid in flesh (Winter and Hermann, 1986; Whitaker and Stommel, 2003). Other studies of the main phenolics reported in eggplants, showed that they are well metabolized and absorbed (Olthof *et al.*, 2001; Olthof *et al.*, 2003), also they show a good antioxidant capacity (Noda *et al.*, 2000; Hanson *et al.*, 2006). The aim of this work was to characterise and compare the proximal composition, mineral content and antioxidant bioactive compounds of eggplant types grown in Sinaloa, Mexico.

## Materials and methods

### Sample preparation

Eggplant fruits from the representative types of Chinese, Philippine, American Hindu, and Thai were used in this work (Fig. 1). Fruit samples of each eggplant type were harvested at commercial ripeness stage from a local farm (24°40'50" N and 107°30'18" W), washed and sorted by colour and size and divided into two groups. The first group was used fresh for proximate and mineral analysis, while the second group was freeze dried and stored at -80 °C, for further evaluations of ascorbic acid, chlorogenic acid and total phenolics.



Fig. 1. Phenotypic differences among eggplant types (from left to right: Chinese, Philippine, American, Hindu, and Thai)

### Proximate composition

Moisture, ash, protein (N x 6.25), crude fibre, fat and carbohydrates (by difference) contents were determined according to AOAC methods (AOAC, 1998). Total dietary fibre was evaluated by the Megazyme total dietary fibre assay procedure, which is based on the AOAC 991.43 method (AOAC, 1998).

### Mineral content

Mineral analysis was done based on AOAC methods (AOAC, 1998). Potassium (K), sodium (Na), calcium (Ca), magnesium (Mg), iron (Fe), zinc (Zn), copper (Cu) and manganese (Mn) were determined by atomic absorption spectroscopy using a Varian SpectrAA 220. Phosphorus (P) was determined colorimetrically at 650 nm in a Varian Cary E1 UV-Vis spectrophotometer.

### Ascorbic acid (Vitamin C)

Ascorbic acid extraction was done according to Özgür and Sungur (1995) with the following modifications; 100 mg of freeze dried sample were mixed with 5 mL of extraction

solution at 5 °C (3% metaphosphoric acid, 8% acetic acid, 1mM EDTA). The extract was filtered through a Whatman No. 1 filter paper and passed through 45 µm nylon syringe filter. Ascorbic acid was quantified according to Doner and Hicks (1981) using a Varian Pro Star 330 photodiode array detector HPLC system and a Varian Bondesil NH<sub>2</sub> column (250 x 4.6 mm). A 3:1 solution of acetonitrile and potassium phosphate (0.05 M) was used as the mobile phase at 1.5 mL min<sup>-1</sup>. Detection was measured at 268 nm with a retention time at 2.1 min. Standard solutions of 0, 0.05, 0.10, 0.15 and 0.20 mg mL<sup>-1</sup> of ascorbic acid were prepared for calibration. Results were expressed in milligram per 100 gram of eggplant on a fresh basis.

### Soluble phenolic compounds

Phenolics extract was obtained according to Whitaker and Stommel (2003) with these modifications; 200 mg of freeze dried sample were mixed with 10 mL of methanol containing 0.5% butylated hydroxytoluene (BHT) and sonicated at room temperature for 15 min in an ultrasonic bath (Fisher Scientific Model FS60). After centrifugation at 16,000 g, supernatant was recovered and re-extracted twice with 10 mL of solvent. Extracts were combined, filtered through Whatman No. 4 paper and passed through 45 µm PTFE syringe filter.

### Total soluble phenolics

Total soluble phenolics were determined using 2 mL aliquots of phenolics extract; the solvent was evaporated at 35 °C by flushing dry N<sub>2</sub> and the residue dissolved in 10 mL of methanol. Total phenols determination was done according to spectrophotometric method based on the colorimetric reaction of the Folin-Ciocalteu reagent (Chun and Kim 2004). Absorbance was measured at 750 nm in a Varian Cary E1 UV-Vis spectrophotometer (Varian, USA). Results were expressed in mg chlorogenic acid equivalents per 100 grams (mg CAE 100g<sup>-1</sup>) of eggplant tissue in a dry basis, using a calibration curve with a standard solution of 0, 0.25, 0.50, 0.75 and 1.00 mg mL<sup>-1</sup> of chlorogenic acid.

### Chlorogenic acid

For chlorogenic acid determination, a 1.5 mL aliquot of phenolics extract was taken, solvent was evaporated at 35 °C by flushing dry N<sub>2</sub> and dissolved in 2mM phosphoric acid in methanol-water (1:1); HPLC analysis was done using binary mobile phase gradient of methanol in 1mM aqueous phosphoric acid and a Phenomenex Luna C<sub>18</sub> column (250 x 4.6 mm) in a Varian Pro Star 330 photodiode array detector HPLC system (Whitaker and Stommel, 2003). Detection was done at 325 nm with a retention time in 19.7 min. Standard solutions of 0, 0.25, 0.50, 0.75 and 1.00 mg mL<sup>-1</sup> of chlorogenic acid were prepared for calibration curve. Results were expressed in milligram per 100 gram of eggplant tissue on a dry basis. The percentage of chlorogenic acid in comparison with total phenols was calculated, as well.

### Total anthocyanins

Total anthocyanin was determined using a spectrophotometric method adapted from Abdel-Aal and Hucl (1999). An eggplant sample of 0.5 g was homogenized with 10 mL of chilled, acidified methanol (95% methanol and 1 N HCl 85:15, v/v). The tube was flushed with nitrogen gas,

agitated for 30 min, and centrifuged at 3000 g for 10 min, and the supernatant was collected. Solution absorbance was measured immediately at 535 and 700 nm. Anthocyanin content was calculated as the concentration of total anthocyanin, expressed as mg of cyanidin-3-glucoside equivalents per 100 g of sample ( $\text{mgC}_3\text{GE } 100\text{g}^{-1}$ ). The molar absorptivity and molecular weight of cyanidin-3-glucoside are 25965/cm/M and 449.2 g per mole, respectively.

#### DPPH antioxidant capacity

Eggplant samples (5 g) were homogenized with 20 mL methanol, until reaching uniform consistency and incubated overnight at 4 °C (Heredia and Cisneros-Zeballos, 2009). Homogenates were centrifuged at 29,000 g for 15 min at 4 °C. Sample aliquots of 150  $\mu\text{L}$  were taken from the clear supernatants and then diluted with a 2,850  $\mu\text{L}$  DPPH solution, previously prepared with methanol, until reaching 1.1 units of absorbance at 515 nm. Methanol was used as control and to zero the spectrophotometer (Agilent Technologies, Mexico). Further readings of all samples were done at 515 nm. The mixture reaction was allowed to react in a shaker until no significant decrease in absorbance was obtained, compared to the methanol-based control for antioxidant activity. The decrease in absorbance was obtained and the results for antioxidant activity were expressed as % radical scavenging activity, calculated as follows: % Radical scavenging activity =  $(\text{absorbance}_{\text{control}} - \text{absorbance}_{\text{sample}} / \text{absorbance}_{\text{control}}) * 100$ . Percentage of radical scavenging activity was plotted against the corresponding concentration of the extract to obtain the  $\text{IC}_{50}$  value, which is defined as the amount of antioxidant material required to scavenge 50% of free radical in the assay system.  $\text{IC}_{50}$  values are inversely proportional to antioxidant activity.

#### ORAC antioxidant capacity

The eggplant methanolic extract sample was also used for ORAC measurements against peroxy radicals (Huang *et al.*, 2002; Prior *et al.*, 2003). Sample extracts, Trolox standard (40  $\mu\text{M}$ ) and reagents were dissolved in 75 mM potassium phosphate buffer, pH 7.4, and assayed on a Bio-Tek Synergy HT plate reader with automatic using 96-well plates. The fluorescein stock solution (FLs) was prepared with 0.1125 g of fluorescein (FL) in 50 mL of the buffer. Next, 100  $\mu\text{L}$  of FLs was diluted in 10 mL of the buffer (FL2). A third FL solution (FL3) was prepared by taking 400  $\mu\text{L}$  of FL2 to 25 mL. The assay was performed at 37 °C. Samples were loaded into the 96-

well plate (25  $\mu\text{L}$ ), with each row containing different samples or dilutions. Two columns were loaded with 25  $\mu\text{L}$  of Trolox and the buffer (blank), respectively. At 15 min, the AAPH peroxy radical solution (2,2'-azobis 2-amidinopropane) dihydrochloride was prepared right with the incubated buffer. The FL3 and AAPH solutions were then transferred into the incubated autoinjector plastic containers. The plate reader was configured to inject 200  $\mu\text{L}$  of FL3, the shaking plate was set at medium intensity for 3 s, injecting 75  $\mu\text{L}$  of AAPH solution, and taking readings for 50 min every 1:27 min (35 cycles) without shaking during readings. The reading mode was fluorescence kinetic with injection (Ex/Em: 485/528). Data were recorded with the GEN-5 software and exported into Excel. Relative fluorescence ( $f_i = F_i/F_1$ , where  $F_i$  is fluorescence at cycle  $i$ ) was calculated for all wells and kinetic readings, and area under the curve (AUC) were calculated for the 35 cycles as  $\text{AUC} = (f_1 + f_{35})/2 + (f_2 + f_3 + \dots + f_{33} + f_{34})$ . The net area under the curve (NAUC) was calculated as  $\text{AUC sample} - \text{AUC blank}$ . ORAC value was then calculated as  $(\text{NAUC sample} / \text{NAUC Trolox}) * 40$  and expressed as  $\mu\text{moles Trolox equivalents per gram of sample } (\mu\text{molTE g}^{-1})$ .

#### Statistical analysis

ANOVA was used to assess statistical differences among eggplant types with a 5% confidence's level. When significance difference was found, Tukey's multiple range tests were carried out to separate means using MINITAB 14.0 (MINITAB, 2004). Data were expressed as means values of three samples  $\pm$  standard deviation.

## Results and discussion

#### Proximate composition

In spite of its small fruits, Thai type showed the highest values in crude fibre, ashes and carbohydrates. Although Thai also showed the highest protein content it was only significantly higher than Chinese and as far as dietary fibre only Hindu had values close to Thai (Tab. 1). All eggplants had moisture content greater than 90%, protein content lower than 1% and low fat with 0.04% (Tab. 1). Similar data were reported in different cultivars, with values ranging from 91.8 to 94.2% for moisture, 0.11 to 1.2% for protein and 0.3% to 0.7% for ash (on fresh weight basis) (Flick *et al.*, 1978; Muñoz de Chavez *et al.*, 1996; Maroto, 2002). Vegetables are characterized for the high content of fibre

Tab. 1. Proximate composition of eggplant types grown in Sinaloa, Mexico ( $\text{g } 100\text{g}^{-1}$  fresh weight)

Component	Chinese	Philippine	American	Hindu	Thai
Water	92.50 $\pm$ 0.11 <sup>a</sup>	92.60 $\pm$ 0.09 <sup>a</sup>	92.70 $\pm$ 0.08 <sup>a</sup>	92.60 $\pm$ 0.04 <sup>a</sup>	90.10 $\pm$ 0.25 <sup>b</sup>
Crude fibre	0.73 $\pm$ 0.01 <sup>b</sup>	0.78 $\pm$ 0.01 <sup>b</sup>	0.78 $\pm$ 0.08 <sup>b</sup>	0.65 $\pm$ 0.02 <sup>c</sup>	1.54 $\pm$ 0.01 <sup>a</sup>
Ash	0.69 $\pm$ 0.05 <sup>b</sup>	0.72 $\pm$ 0.01 <sup>b</sup>	0.36 $\pm$ 0.08 <sup>c</sup>	0.48 $\pm$ 0.02 <sup>c</sup>	1.04 $\pm$ 0.01 <sup>a</sup>
Protein	0.65 $\pm$ 0.06 <sup>b</sup>	0.69 $\pm$ 0.09 <sup>ab</sup>	0.67 $\pm$ 0.13 <sup>ab</sup>	0.75 $\pm$ 0.05 <sup>ab</sup>	0.90 $\pm$ 0.07 <sup>a</sup>
Fat	0.04 $\pm$ 0.01 <sup>a</sup>	0.03 $\pm$ 0.00 <sup>a</sup>	0.04 $\pm$ 0.01 <sup>a</sup>	0.03 $\pm$ 0.01 <sup>a</sup>	0.04 $\pm$ 0.01 <sup>a</sup>
Carbohydrates <sup>+</sup>	6.12 $\pm$ 0.11 <sup>bc</sup>	5.96 $\pm$ 0.06 <sup>c</sup>	6.23 $\pm$ 0.27 <sup>bc</sup>	6.14 $\pm$ 0.08 <sup>b</sup>	7.92 $\pm$ 0.37 <sup>a</sup>
Dietary fibre	2.76 $\pm$ 0.14 <sup>b</sup>	1.61 $\pm$ 0.15 <sup>c</sup>	2.63 $\pm$ 0.18 <sup>b</sup>	3.59 $\pm$ 0.08 <sup>a</sup>	3.93 $\pm$ 0.15 <sup>a</sup>

Mean values in a row with different letters are significantly different at  $P \leq 0.05$ . Mean values of three samples  $\pm$  SD

<sup>+</sup>Carbohydrates (%) =  $100 - (\% \text{water} + \% \text{crude fibre} + \% \text{ash} + \% \text{protein} + \% \text{fat})$ .

and are considered as a primary source for humans. The highest content (>3.5%) in dietary fibre found in Thai and Hindu was significantly different than the rest of the eggplant types. Sánchez-Castillo *et al.* (1999), analyzed the dietary fibre content in different vegetables grown in Mexico reporting a 2.4% values for eggplants, while a study carried out in Chile by Pak (2000), found 1.3% in cooked eggplants without skin and seeds; Takeyama *et al.* (2002) reported a content of around 2.4% in a Japanese cultivar, and Rehman *et al.* (2003) found a value of 1.5% of dietary fibre in eggplants cultivated in Pakistan. An average intake of 25 g day<sup>-1</sup> of dietary fibre in adults is recommended by the American Dietetic Association (based on a 2000 kcal day<sup>-1</sup> diet) (Marlett *et al.*, 2002). Based on this value, an intake of 100 g day<sup>-1</sup> of the eggplant types analyzed in this study could account for 6.5 to 16% of the recommended daily intake (RDI).

#### Mineral content

Tab. 2 provided results of mineral composition for the five eggplant types. Hindu had the highest values for K, Ca, and Zn; along with American it has the highest concentrations of P, Mg and Mn. Philippine reported the highest Fe content, and no differences among the five types were found for Cu concentration. Although Na content varied widely, it was statistically the same for Hindu,

American and Chinese. Ekholm *et al.* (2007) found a similar pattern and mineral content in eggplants cultivated in Finland, as compared to our work, where K showed the highest concentration (175 mg 100g<sup>-1</sup>) and Cu showed the lowest result (0.03 mg100g<sup>-1</sup>). On the other hand, a study carried out in eggplants grown in Saudi Arabia by Mohamed *et al.* (2003) showed a different mineral concentration (mg 100g<sup>-1</sup>) reporting 274 for Ca, 222 for Na and 212 for K. Those values are higher than those found in our study. Eggplants are a good source of biologically essential minerals like K, Ca, Mg, P, Na and Fe; their contents are similar to those found in tomatoes and higher than those reported in carrots, potatoes and onions, which are the most common vegetables consumed in Mexico.

#### Ascorbic acid (Vitamin C)

The ascorbic acid content in eggplant types (Tab. 3) showed values ranging between 7.4 and 22 mg 100g<sup>-1</sup> with Thai and Hindu with lower and highest content respectively. All of our results are higher than the 4 mg ascorbic acid 100g<sup>-1</sup> reported in Spain (Esteban *et al.*, 1992) and Turkey (Dürüst *et al.*, 1997). Prohens *et al.* (2007) found 1.4, 1.6 and 1.8 mg ascorbic acid 100g<sup>-1</sup> for a Thai ('Thai Round'), a Chinese ('Kermit') and a European ('Black Beauty') cultivars, respectively. On the other hand, Hanson *et al.* (2006) quantified ascorbic acid contents of

Tab. 2. Mineral content of eggplant types grown in Sinaloa, Mexico (mg 100g<sup>-1</sup> fresh weight)

Element	Chinese	Philippine	American	Hindu	Thai
K	151.21±17.93 <sup>b</sup>	121.06±4.05 <sup>c</sup>	152.15±8.59 <sup>ab</sup>	191.18±1.49 <sup>a</sup>	176.46±6.11 <sup>b</sup>
Ca	28.00±0.77 <sup>c</sup>	32.80±4.97 <sup>c</sup>	31.36±1.06 <sup>c</sup>	59.63±7.71 <sup>a</sup>	45.08±1.14 <sup>b</sup>
P	21.21±0.56 <sup>b</sup>	13.80±0.86 <sup>c</sup>	29.61±3.28 <sup>a</sup>	33.52±1.34 <sup>a</sup>	30.42±1.25 <sup>a</sup>
Mg	15.29±0.86 <sup>c</sup>	15.74±0.95 <sup>c</sup>	25.35±2.13 <sup>a</sup>	28.96±1.97 <sup>a</sup>	20.88±1.17 <sup>b</sup>
Na	9.40±0.28 <sup>a</sup>	5.76±0.65 <sup>b</sup>	8.49±0.69 <sup>a</sup>	11.54±2.65 <sup>a</sup>	5.61±0.93 <sup>b</sup>
Fe	2.40±0.17 <sup>b</sup>	3.13±0.32 <sup>a</sup>	0.86±0.05 <sup>d</sup>	1.53±0.25 <sup>c</sup>	1.80±0.26 <sup>c</sup>
Zn	0.33±0.04 <sup>d</sup>	0.26±0.03 <sup>d</sup>	0.51±0.01 <sup>b</sup>	0.78±0.04 <sup>a</sup>	0.45±0.00 <sup>c</sup>
Mn	0.36±0.01 <sup>b</sup>	0.30±0.02 <sup>c</sup>	0.41±0.02 <sup>ab</sup>	0.44±0.02 <sup>a</sup>	0.39±0.01 <sup>b</sup>
Cu	0.15±0.02 <sup>a</sup>	0.13±0.03 <sup>a</sup>	0.15±0.01 <sup>a</sup>	0.15±0.01 <sup>a</sup>	0.18±0.03 <sup>a</sup>
Total	228.35	192.98	248.89	327.73	281.27

Mean values in a row with different letters are significantly different at P≤0.05. Mean values of three samples±SD

Tab. 3. Nutraceutical components and antioxidant capacity of eggplant types grown in Sinaloa, Mexico

Attribute	Chinese	Philippine	American	Hindu	Thai
Ascorbic acid (mg 100g <sup>-1</sup> of fresh sample)	*11.2±2.5 <sup>b</sup>	8.6±0.6 <sup>b</sup>	8.9±2.2 <sup>b</sup>	22.0±4.1 <sup>a</sup>	7.4±2.9 <sup>b</sup>
Total soluble phenols (mg CAE 100g <sup>-1</sup> of dry sample)	1350.0±37.5 <sup>d</sup>	1562.7±57.3 <sup>c</sup>	1512.5±21.7 <sup>c</sup>	1750.0±43.3 <sup>b</sup>	2049.8±77.8 <sup>a</sup>
Chlorogenic acid (mg 100g <sup>-1</sup> of dry sample)	953.3±47.3 <sup>c</sup>	916.7±45.1 <sup>c</sup>	860.0±30.0 <sup>c</sup>	1200.0±0.0 <sup>b</sup>	1700.0±100 <sup>a</sup>
Chlorogenic acid %**	70.61	58.66	56.87	68.57	82.93
Total anthocyanins***	128.7±1.5 <sup>b</sup>	161.1±2.9 <sup>a</sup>	123.6±5.7 <sup>b</sup>	82.8±2.6 <sup>c</sup>	3.9±0.2 <sup>d</sup>
ORAC****	296.2±16.7 <sup>b</sup>	538.9±61.2 <sup>a</sup>	94.8±12.4 <sup>c</sup>	352.1±24.5 <sup>b</sup>	102.8±23.2 <sup>c</sup>
DPPH*****	56.1±3.3 <sup>c</sup>	92.5±0.3 <sup>a</sup>	78.5±2.9 <sup>b</sup>	82.1±4.1 <sup>ab</sup>	77.8±7.8 <sup>b</sup>
IC <sub>50</sub> (DPPH, µg)	0.0067	0.0033	0.0092	0.0039	0.0046

Mean values in a row with different letters are significantly different at P≤0.05. \*Mean values of three samples±SD,

\*\*%Chlorogenic acid=(chlorogenic acid/total phenols)X100, \*\*\*mgC<sub>3</sub>GE 100g<sup>-1</sup>,\*\*\*\*µmolTE g<sup>-1</sup> dry basis, \*\*\*\*\*% Inhibition of DPPH

10.2, 7.3 and 5.2 mg 100g<sup>-1</sup> for Hindu, Philippine, and Chinese eggplant types respectively, in all cases the same types show higher values in our trial. To put consumption in perspective, Young (1999) suggested a recommended daily intake (RDI) of vitamin C in the range from 60 to 100 mg. Eggplant consumptions of 100 g day<sup>-1</sup> as analyzed in this study, will account for 7 to 22% of the RDI.

#### Total soluble phenols

Total soluble phenols in our work (Tab. 3) ranged from 1350 to 2049 mg CAE 100g<sup>-1</sup> in Chinese and Hindu, respectively a significant gradient was found among the rest of the eggplant types. Our results were higher than those reported by Raigón *et al.* (2008), their report was based on a study of 31 *S. melongena* cultivars from around the world with total phenolic content ranged from 545 to 1048 mg CAE 100g<sup>-1</sup>, Ninfalli *et al.* (2005) also reported 820 and 925 mg CAE 100g<sup>-1</sup> for 'Black Beauty' and 'Violetta Lunga' varieties. Using five *S. melongena* cultivars of varied colours, Akanitapichat *et al.* (2010) reported values from 739 to 1116 mg GAE 100g<sup>-1</sup>, and Hanson *et al.* (2006) found values from 740 to 1430 mg GAE 100g<sup>-1</sup> in cultivars from around the world. In the other hand, a study by Okmen *et al.* (2009) showed contents from 878 to 1984 mg GAE 100g<sup>-1</sup> in 26 Turkish cultivars, such data covered the whole range found in our study, except for the highest value we found in Thai.

#### Chlorogenic acid

Chlorogenic acid is one of the most ubiquitous phenolic acid in plants, particularly in the solanaceas (Clifford, 1999; Niggeweg *et al.*, 2004). It has been reported that following consumption it is absorbed and metabolized by humans having a beneficial effect on health (Olthof *et al.*, 2001; Olthof *et al.*, 2003). The chlorogenic acid content found in our work resulted in a range from 860 to 1700 mg 100g<sup>-1</sup>, American showed the lowest amount, while Thai reach the highest value. Winter and Herrmann (1986) reported 902 and 821 mg 100g<sup>-1</sup> of chlorogenic acid for Italian and Spanish eggplant cultivars, respectively. Comparing with our data, these results are similar to the ones reported for Philippine and American, respectively. Papanga *et al.* (1999) and Whitaker and Stommel (2003) found 947 and 960 mg 100g<sup>-1</sup> of chlorogenic acid in eggplant flesh, respectively, which is similar to our data for Chinese. In the other hand, Mattila and Hellström (2007) reported a chlorogenic acid content of 492 mg 100g<sup>-1</sup> in an eggplant cultivated in Finland and Singh *et al.* (2009) found a chlorogenic acid content of 498 and 805 mg 100g<sup>-1</sup> for 'Millionaire' and 'Blackbell' cultivars. The levels of these studies are lower than all the eggplant types analyzed in our work. Several studies related to phenolic acids determination in eggplants, concluded that chlorogenic acid is the main phenolic acid in the flesh of this vegetable, but none of them, have reported it in terms of percentage as compared to the total phenols content. Analyzing data from total phenols and chlorogenic acid shows that chlorogenic acid represents more than 56% of total phenols in all analyzed eggplant types (Tab. 3). Data variation in eggplant total phenols and chlorogenic acid among different reports is mainly attributed to solvent and extraction techniques used for extraction of phenolic

compounds and such topic is analyzed by Luthria and Mukhopadhyay (2006).

#### Anthocyanins

Among the purple eggplant types, the highest amount of anthocyanins was observed in Philippine with 161 mg C<sub>3</sub>GE 100g<sup>-1</sup>, which coincides with the results for ORAC and DPPH antioxidant activity, while the lowest result was found in Hindu with 83 mg C<sub>3</sub>GE 100g<sup>-1</sup> (Tab. 3). No statistical differences between Chinese and American were found with 129 and 124 mg C<sub>3</sub>G 100g<sup>-1</sup>, respectively. Anthocyanins data obtained in this study of purple fruits are higher than those reported by Papanga *et al.* (1999) and Sadilova *et al.* (2006) whom reported 55 and 64 mg 100g<sup>-1</sup>, respectively. In the other hand, our anthocyanins data in Hindu and American are similar to those reported by Lo Scalzo *et al.* (2010) and Koponen *et al.* (2007) who measured 90 and 107 mg 100g<sup>-1</sup>. Former reports show that Bor *et al.* (2006) sampled *S. melongena* at retails in Taiwan, while Wu *et al.* (2006) in a comprehensive sample at 12 cities around the U.S. reported anthocyanin content values ranging from 167 and 1067 mg 100g<sup>-1</sup> in commercial eggplants at retail points, which is higher than the amounts found in our five types study. All of these anthocyanin comparative studies used delphinidin or delphinidin derivatives as standard compounds for analysis.

#### Antioxidant capacity: DPPH radical scavenging activity and ORAC

Antioxidant activity was evaluated using DPPH and AAPH free radicals. AAPH free radical was used in the ORAC assay and results were expressed as μmoles Trolox equivalents per gram of sample (μmolTE g<sup>-1</sup>), showing significant differences (P≤0.05) among the five types (Tab. 3). Results ranged from 95 to 539 μmolTE g<sup>-1</sup>, with American and Philippine at each extreme. Thai samples (103 μmolTE g<sup>-1</sup>) had no significant differences as compared to the American type, while Hindu and Chinese samples showed no significant differences with 296 and 352 μmolTE g<sup>-1</sup>, each. IC<sub>50</sub> is defined as the amount of antioxidant material required to scavenge 50% of free radical in the assay system. Its value are inversely proportional to the antioxidant activity, the smaller the number the highest the scavenging activity. All eggplant types ranged from IC<sub>50</sub> values of 0.0033 to 0.0092. According to these, Philippine had the highest antioxidant activity with an IC<sub>50</sub> of 0.0033 μg, while American has the lowest with only 0.0092 μg. Methodological similarities among the ORAC and DPPH methods may be due to the presence and specificity of the diverse bioactive molecules found in the evaluated eggplant types.

#### Conclusions

The five evaluated eggplant types specially Hindu and Thai, have significant content of some human promoting health components, such as crude and dietary fibre, as well as biologically essential minerals like K, Ca, Mg, P, Na and Fe. They also provide important amounts of antioxidants like ascorbic acid and soluble phenolic compounds (mainly chlorogenic acid), as well as significant antioxidant.

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