Journal of Fundamental and Applied Sciences

ISSN 1112-9867

Available online at http://www.jfas.info

# STUDY OF ANTIOXIDANT CAPACITY OF DIFFERENT PARTS OF TWO SOUTH ALGERIAN EGGPLANT CULTIVARS

C. Boubekri[1,2], A. Rebiai[1] and T. Lanez*[1]

[1]University of El Oued, VTRS Laboratory, B.P.789, 39000, El-Oued, Algeria

[2]University of Biskra, Chemistry department, PO Box 145, 07000, Biskra, Algeria

Received: 13 September 2012 / Accepted: 12 October 2012 / Published online: 31 December 2012

## ABSTRACT

In this study the antioxidant capacity of ethanolic EE and water WE extracts from different parts (calyx, peel, and pulp) of eggplant (*Solanum melongena L)* were evaluated using cyclic voltammetry. The antioxidant capacity of different parts of eggplant was measured using ascorbic acid equivalent antioxidant capacity assays. The peel extracts of both dark purple and white samples showed the highest antioxidant capacity (66.78 and 75.62 mg/g) followed by pulp (16.54 and 30.56 mg/g), and calyx (14.82 and 21.27 mg/g). These results indicate that antioxidant capacity of eggplant varied by parts and solvents.

**Keywords:** Eggplant, Solanum melongena L, antioxidant capacity, cyclic voltammtry, ascorbic acid.

## 1. INTRODUCTION

*Solanum melongena L* fruit commonly known as eggplant or aubergine is a tropical fruit native to India and it varies in color, shape, and size, depending on the cultivar. Fruits are purple, white or striped [1] and are ranked amongst the top ten vegetables in terms of antioxidant capacity due to the fruit phenolic and flavonoic constituents [2]. In folk medicine, eggplant is indicated since ancient times for the treatment of several diseases, including diabetes, arthritis, asthma and bronchitis [3].

Author Correspondence, e-mail: touhami-lanez@univ-eloued.dz

ICID: 1025901

The dark purple and white eggplant varieties are the most common type sold commercially in Algeria and widely used as a vegetable in cooking; their peak growing season is from November to January.

An eggplant of 100 g size contains 30 calories, 0 g of total fat, 0 g of saturated fat, 8 g of total carbohydrate, 2 g of dietary fiber, 4 g of sugars, and 2% of daily values of vitamin C [4].

The chemical composition and antioxidant capacities of eggplant of many countries have been widely studied by a lot of scientific research groups [5-7], but only a few reports can be found in literature on Algerian eggplants. This motivated us to explore the antioxidant capacity of south Algerian eggplant. The aim of this work is to measure the in vitro antioxidant capacity of the ethanolic and water extracts of south Algerian eggplants. We used electrochemical techniques based on cyclic voltammetry assay [8-11].

## 2. EXPERIMENTAL SECTION

### 2.1. Chemical

Ethanol (99%), was purchased from Sigma-Aldrich Co. ascorbic acid (99.7%), was purchased from Merck Co. all other reagents used were of analytical grade.

### 2.2. Plant material

The two varieties of eggplant fruits, labeled as dark purple and white (figure 1) were purchased fresh from a local market in Guemar (El-Oued), Algeria from November 2011 to December 2011. After collection, the samples were analyzed for antioxidant evaluation within 6 months after harvest.

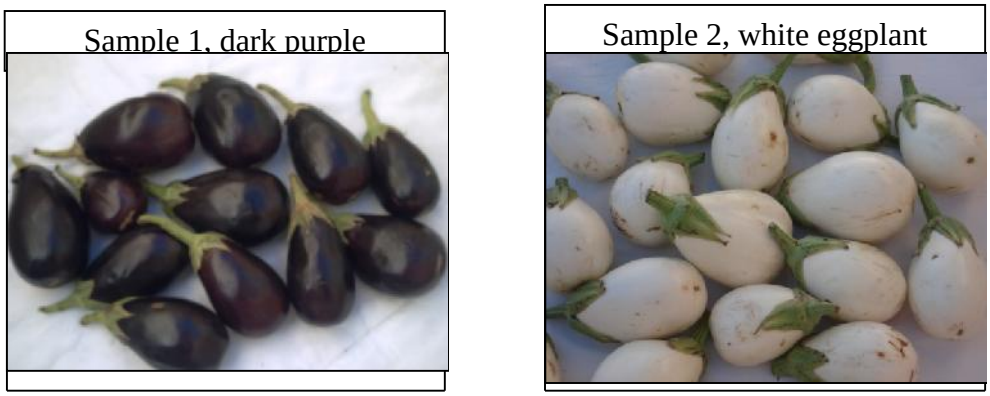


**Fig.1.** The two varieties of eggplants used in this study

### 2.3. Instrument

PGP301 potentiostat with voltamaster 4 version 7.08 soft ware (radiometer analytical SAS), rotary evaporator (IKA Evaporator RV 06-ML).

### 2.4. Extraction of eggplant constituents

Fresh eggplant of each variety was cleaned, air dried, and ground to a powder. The powdered sample (5g) was then extracted with 100 mL of absolute ethanol for 2 hours using a Soxhlet, the filtrate was recovered and the insoluble residue of the recovered filtrate was removed by filtering through Whatman No. 4 paper and was dried in a vacuum using a rotary evaporator, the obtained residue was redissolved in absolute ethanol, transferred into round bottom flask and evaporated to yield (6.41 – 9.30 %) for dark purple eggplant and (4.69 – 11.86 %) for white eggplant (table 1). The remaining portion which did not dissolved in ethanol was dissolved in 100 water and then evaporated to yield (8.04 – 27.43%) for dark purple eggplant and (1.25 – 11.97 %) for white eggplant (table 1). All dry extracts fractions were sealed in a glass flask and stored at low temperature until used.

**Table 1.** Extraction yield from different part of eggplant with ethanol and water

| Variety | parts | EE extracts | | WE extracts | |
|---|---|---|---|---|---|
| | | Masse (g) | Yield (%)* | Masse (g) | Yield (%)* |
| Dark purple eggplant | Calyx | 0,3463 | 6,93 | 1,3717 | 27,43 |
| | Pulp | 0,4648 | 9,30 | 1,0162 | 20,32 |
| | Peel | 0,3203 | 6,41 | 0,4020 | 8,04 |
| White eggplant | Calyx | 0,5930 | 11,86 | 0,5984 | 11,97 |
| | Pulp | 0,5279 | 10,56 | 0,4072 | 8,14 |
| | Peel | 0,2343 | 4,69 | 0,0624 | 1,23 |

* weight of extracts/ weight of dried eggplant parts) × 100

### 2.5. Evaluation of antioxidant capacity

The measurement of the antioxidant capacity of the studied samples of eggplant was performed using an electrochemical method based on cyclic voltammetry techniques. Cyclic voltammetry measurements were performed in an electrochemical cell with a volumetric capacity of 50 mL containing a glassy carbon electrode (GCE) working electrode (radiometer analytical SAS), a Pt wire counter electrode, and an $Hg/Hg_2Cl_2$ reference electrode (saturated with KCl). The potential was swept in direct scanning mode starting from -200 to +800 mV

with a scanning rate of 100 mV/s. To avoid reducing the sensitivity of the working electrode, the latter was polished after each cycle by rubbing its surface using alumina oxide (particle size 0.3µm) before every electrochemical assay. After polishing it was rinsed thoroughly with bidistilled water for 30 s.

The antioxidant capacity of the studied samples of eggplant was obtained using the current density of the anodic curve of the voltammogram. The calibration graph is obtained by plotting the current density of the anodic curve of the voltammogram of each sample of the standard versus its concentration. Ascorbic acid was used as a standard in the calculation of antioxidant capacity of the studied sample of eggplant because of its wide spreading in nature and also because its anodic current density displays excellent linearity toward ascorbic acid concentrations [12, 13].

## 3. RESULTS AND DISCUSSION

### 3.1. Antioxidant capacities

Antioxidant capacities in the present study were assessed by using cyclic voltammetry assays due to their excellent reproducibility. The Cyclic voltammograms, at different concentrations of ascorbic acid (0.018 to 0.190 g/L) obtained in pH 7, 0.2 M phosphate buffer solution as a supporting electrolyte using a 3 mm-diameter glassy carbon electrode present typical irreversible oxidation processes with the existence of an irreversible one oxidation peak at 260 mV (figure 2a). As can be seen there is an increase in peak current with the increase in ascorbic acid concentrations which leads to a linear relation between these two parameters (figure 2b).

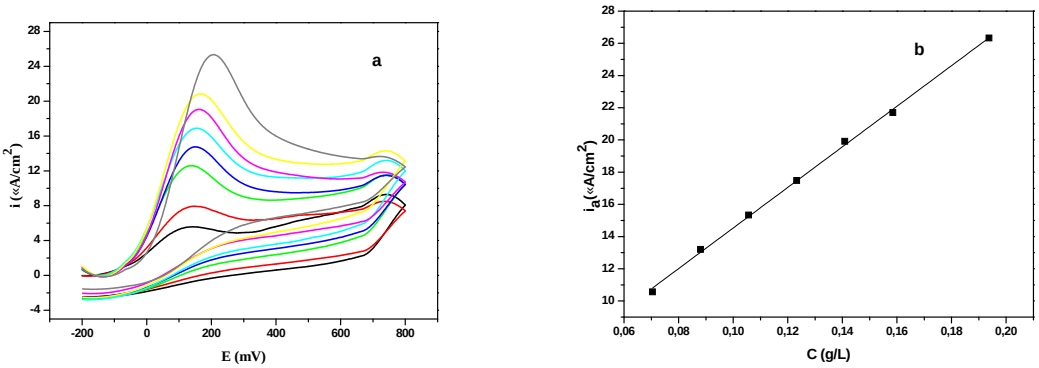


**Fig.2.** Cyclic voltammograms referring to different ascorbic acid concentrations (a), calibration curve obtained by cyclic voltammetry method expressed as ascorbic acid equivalents/L (b).

In order to express the antioxidant capacity of the eggplant extracts in equivalent terms of ascorbic acid equivalent antioxidant capacity (AEAC), different concentrations of the standards ascorbic acid were plotted verses the anodic current density ($i_a$) (figure 2b). The values are presented in table 2.

**Table 2.** Anodic current density obtained from cyclic voltammetry of ascorbic acid.

| C (g/L) | $i_a$ ($\mu A.cm^{-2}$) |
|---|---|
| 0,018 | 3,023 |
| 0,035 | 5,875 |
| 0,053 | 8,407 |
| 0,070 | 10,56 |
| 0,088 | 13,2 |
| 0,106 | 15,33 |
| 0,123 | 17,48 |
| 0,141 | 19,91 |
| 0,159 | 21,69 |
| 0,194 | 26,32 |

The equation obtained from the linear calibration graph in the studied concentration range for ascorbic acid is, $y = 132.1x + 1.189$ (where y represents the value of the anodic current density and x, the value of standards concentration, expressed as g/L), with a correlation coefficient of $R^2 = 0.998$.

### 3.2. Evaluation of antioxidant capacity of dark purple eggplant sample

As it can be seen from voltammograms of figure 3.4 and 5 the ethanolic and water extracts of different parts of dark purple eggplant do not response in the same manner as the standard ascorbic acid, all voltammograms of both extracts represent two peaks, one for oxidation at around 172.7 to 194.3 mV and another for reduction at 12.3 to 105.6 mV. This reversible electrochemical behavior of EE and WE extracts may indicate that, under this electrochemical conditions, the eggplant extract contain a different polyphenolic content of that of the standard ascorbic acid.

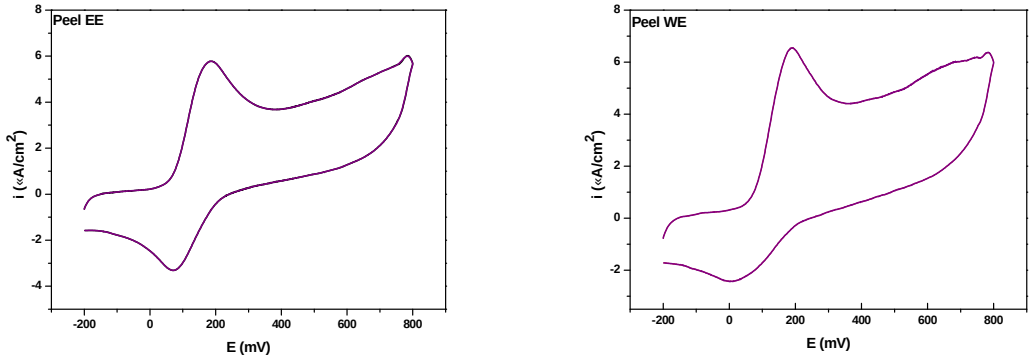


**Fig.3.** Cyclic voltammograms of **peel** of **dark purple eggplant** EE and WE extracts in pH 7, 0.2M phosphate buffer solution at scan rate 100 mV/s.

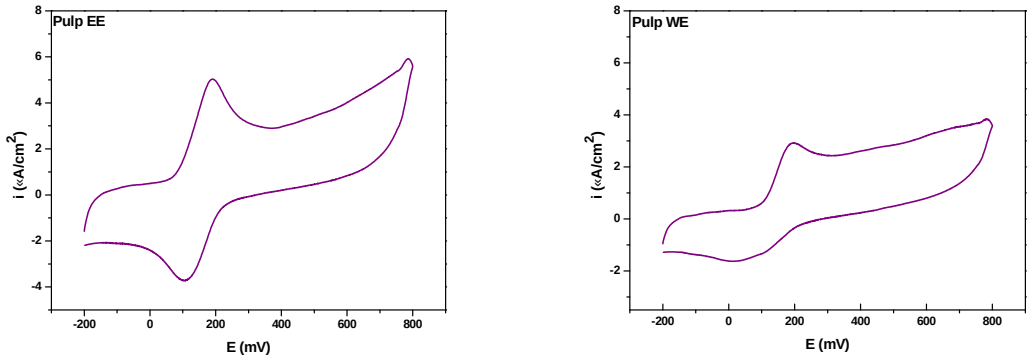


**Fig.4.** Cyclic voltammograms of **pulp** of **dark purple eggplant** EE and WE extracts in pH 7, 0.2M phosphate buffer solution at scan rate 100 mV/s.

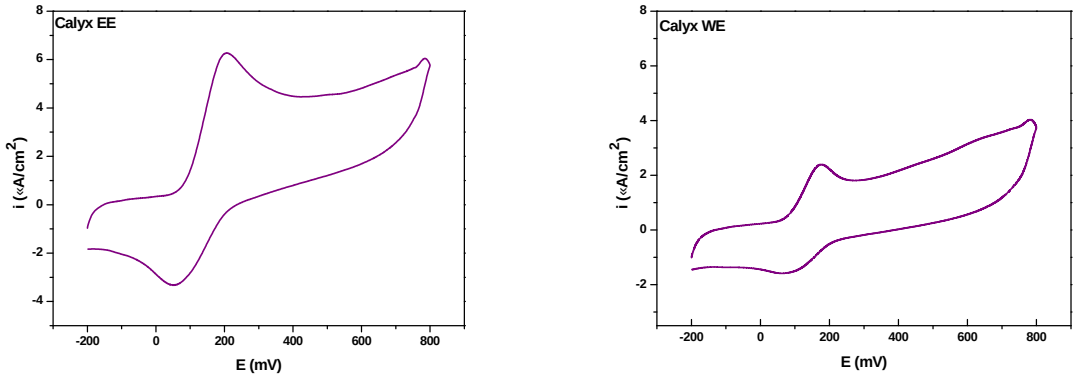


**Fig.5.** Cyclic voltammograms of **calyx** of **dark purple eggplant** EE and WE extracts in pH 7, 0.2M phosphate buffer solution at scan rate 100 mV/s.

Electrochemical data obtained from voltammograms of EE and WE extracts of studied dark purple eggplant samples are summarized in table 3.

**Table 3.** Electrochemical data of EE and WE extracts of different parts of dark purple eggplant.

| Extract | parts | Epa (mV) | ipa (µA/cm$^2$) | Epc (mV) | ipc (µA/cm$^2$) |
|---|---|---|---|---|---|
| EE | calyx | 172,7 | 2,533 | 49.9 | -3.33 |
| | pulp | 189,8 | 3,188 | 105.6 | - 3.70 |
| | peel | 194,3 | 6,729 | 72.6 | - 3.33 |
| WE | calyx | 205,7 | 6,509 | 76.1 | -1.58 |
| | pulp | 190,9 | 5,103 | 17.3 | -1.66 |
| | peel | 187,5 | 5,838 | 12.3 | -2.42 |

### 3.3. Evaluation of antioxidant capacity of white eggplant sample

Figures 6, 7 and 8 indicate that peel ethanolic and water extracts of white eggplant present the same irreversible electrochemical behavior of that of the standard ascorbic acid, although with oxidation potential value is less positive than ascorbic acid, around 12,3 to 103,2 mV, this may indicate that, under this electrochemical conditions, the peel of white eggplant extract contain the same polyphenolic content of the standards ascorbic acid.

All the other eggplant extracts behave in similar manner to that of dark purple eggplant extracts.

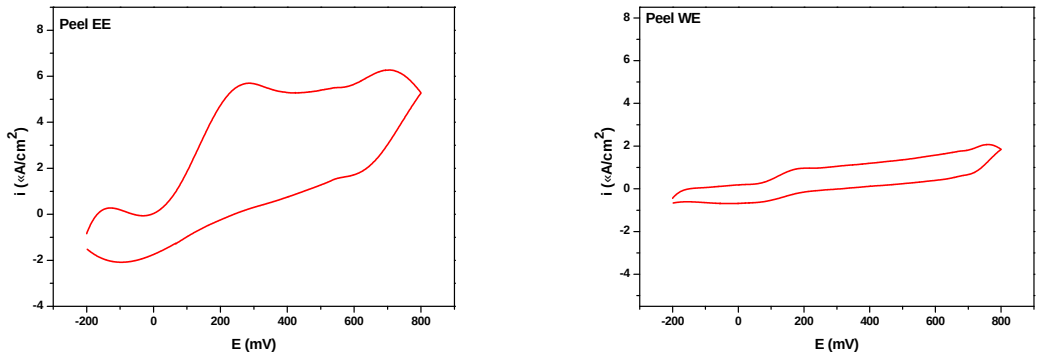


**Fig.6.** Cyclic voltammograms of **peel** of **white eggplant** EE and WE extracts in pH 7, 0.2M phosphate buffer solution at scan rate 100 mV/s.

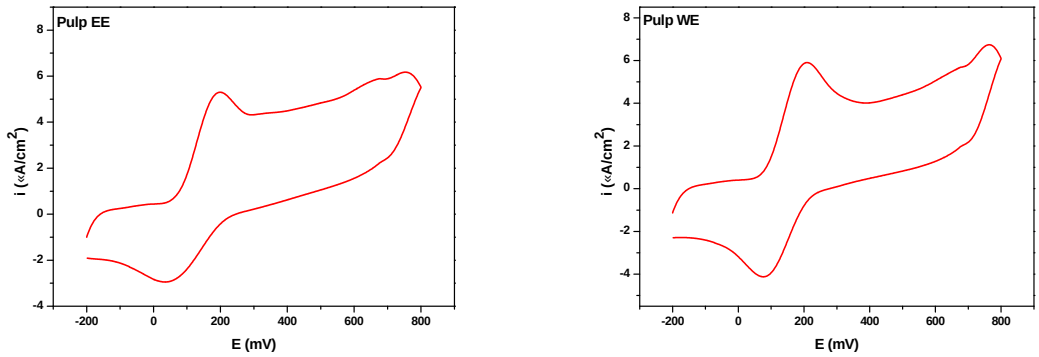


**Fig.7.** Cyclic voltammograms of **peel** of **white eggplant** EE and WE extracts in pH 7, 0.2M phosphate buffer solution at scan rate 100 mV/s.

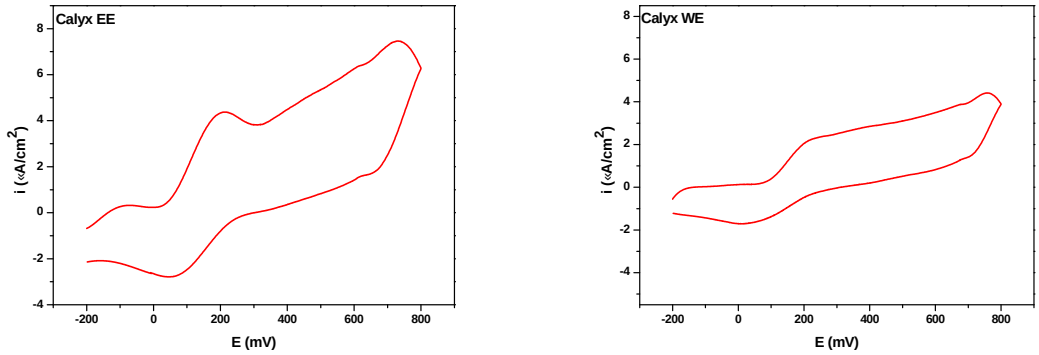


**Fig.8.** Cyclic voltammograms of **calyx** of **white eggplant** EE and WE extracts in pH 7, 0.2M phosphate buffer solution at scan rate 100 mV/s.

Electrochemical data calculated from voltammetric measurements of voltammograms of figures 6, 7 and 8 are presented in table 4.

**Table 4.** Electrochemical data of EE and WE extracts of different parts of white eggplant.

| Extract | parts | Epa (mV) | ipa (µA/cm$^2$) | Epc (mV) | ipc (µA/cm$^2$) |
|---|---|---|---|---|---|
| EE | calyx | 181,8 | 4,683 | 55.8 | -2.92 |
| | pulp | 189,8 | 5,558 | 34.4 | -2.92 |
| | peel | 247,7 | 5,779 | - | - |
| WE | calyx | 202,3 | 2,19 | 27.8 | -1.64 |
| | pulp | 200 | 6,099 | 79.5 | - 4.14 |
| | peel | 156,8 | 0,8922 | - | - |

The ascorbic acid equivalent antioxidant capacity (AEAC) of different parts of the two studied eggplant extracts calculated from the calibration graphs is summarized in table 5.

**Table 5.** Antioxidant capacities of different parts of the two different varieties of eggplant.

| Variety | parts | Ascorbic acid antioxidant capacities | |
|---|---|---|---|
| | | EE extracts (mg/g) | WE extracts (mg/g) |
| Dark purple eggplant | calyx | 7.13 | 13.64 |
| | pulp | 11.07 | 12.76 |
| | peel | 61.24 | 38.73 |
| White eggplant | calyx | 18.98 | 1.78 |
| | pulp | 28.09 | 41.87 |
| | peel | 67.15 | - |

AEAC values for different parts of EE and WE of studied eggplant indicate that peel of white variety was the most effective with the highest AEAC value (67,15 mg/g), followed by pulp AEAC value (41,87 mg/g). A statistically significant difference in antioxidant capacity determined by cyclic voltammetry assay was found between EE and WE extracts for all eggplant parts. No significant difference was found between pulp of EE and WE extracts for dark purple variety.

## 4. CONCLUSIONS

The present study demonstrated the in vitro antioxidant capacities of two south Algerian eggplant varieties (white and dark purple). It is clear from these in vitro assays that white and dark purple eggplant types have moderate antioxidant capacity; however white variety had better anti-oxidant capacities than dark purple variety. The results also show that the antioxidant capacity of peel of both white and dark purple eggplants, expressed in terms of ascorbic equivalent antioxidant capacity (AEAC) is higher than that obtained for calyx and pulp. Electrochemical behavior of peel of white eggplant extract indicates that the later has a different polyphenolic contents.

## 5. REFERENCES

[1] Timberlake C. F. Anthocyanins in fruit and vegetables. In J. Friend, & M. J. C. Rhodes (Eds.), Recent advances in the biochemistry of fruit and vegetables. New York: Academic Press, 1981, pp. 221–247.

[2] Cao G., Sonic E., Prior R. L., J. Agri. Food Chem, 1996, 44, 3426–3431.

[3] Silva M.E., Santos R.C., Leary M.C., Brazilian Archives of Biology and Technology 1999, 42(3), 339-342.

[4] Matsubara K., J Agric Food Chem. 2005, 53(16), 6272-6275.

[5] Torunn S., Remberg S. F., Kare A., Food Chem., 2009, 113, 85–91.

[6] Pannarat A., Kallayanee P., Kwunchai N., Suparichart P., Food Chem. Toxicol., 2010, 48, 3017-3021.

[7] Shiro I., Hiroshi O., Kunimitsu F., Cientia Horticulturae, 1994, 59, (3), 171-176.

[8] Rebiai A., Lanez T., Belfar M.L., Int. J. Pharmacol. 2011, 7 (1), 113-118.

[9] Campanella L., Favero G., Persi L., Tomassetti M., J. Pharm. Biomed. Anal., 2001, 24, 1055-1064.

[10] Cosio M. S., Buratti S., Mannino S. Denedetti S., Food Chem., 2006, 97, 725–731.

[11] Saha M. A., Alia M., Rebiai A. and Lanez T., J. Fun. App. Sci., 2011, 3(2), 35-43.

[12] Laskar R. A., Roy I. N., Begum N. A., Food Chem., 2010, 122, 233–237.

[13] Oyaizu, M. Studies on product of browning reaction prepared from glucose amine. Jpn. J. Nutr. 1986, 44, 307–315.

**How to cite this article**
Boubekri C, Rebiai A and Lanez T. Study of antioxidant capacity of different parts of two south Algerian eggplant cultivars. J Fundam Appl Sci. 2012, 4(2), 164-174.