

Antioxidant activity phenolics flavonoids and proanthocyanidins content of *Senecio anteuphorbium*

ABSTRACT

Aims: The present study aimed to evaluate the antioxidant activity of *Senecio anteuphorbium* and to determine total phenolics, flavonoids and proanthocyanidins content of this plant from Southern Anti-Atlas of Morocco. Moreover the effect of solvent and heat was also investigated.

Place and Duration of Study: Department of biology, laboratory of Biochemistry and Molecular Biology Faculty of Sciences, University Hassan II, between August 2013 and November 2013.

Methodology: we used *Senecio anteuphorbium* as a plant material which was subjected to a decoction, maceration (with both water and methanol) and soxhlet extraction. Ferric reducing/antioxidant power (FRAP) and 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical scavenging tests were used to evaluate antioxidant activity. Folin- Ciocalteau reagent serves to determine total phenolic content, aluminium trichloride method for flavonoids and a mixture of vanillin and hydrochloric acid for proanthocyanidins; employing colorimetric method.

Results: Results obtained revealed that *Senecio anteuphorbium* possesses a high antioxidant capacity that has a positive correlation with quantified phytochemicals ($R^2=0.96/0.9/0.81$). Polyphenols ranged from 21.53 ± 1.03 mg GAE/ gE or 20.38 ± 0.76 mg TAE/gE to 2.46 ± 0.11 GAE/ gE or 2.33 ± 0.09 mg TAE/gE, flavonoids registered the highest amount: 39.47 ± 1.01 mg RE/gE or 26.59 ± 0.24 mg QE/gE, followed by proanthocyanidins: 36.66 ± 1.26 mgCE/gE. In addition when methanol is combined with heat, it seems to be the appropriate method to extract antioxidant compounds.

Conclusion: The present results reveal that *Senecio anteuphorbium* is a potent source of natural antioxidants, containing a mixture of phenolic, flavonoid and proanthocyanidin compounds that could have a great importance as therapeutic agents in preventing oxidative damages.

Keywords: *Senecio anteuphorbium*, antioxidant, phenolics, flavonoids, proanthocyanidins, DPPH, FRAP.

1. INTRODUCTION

The antioxidant hypothesis says that "as antioxidants can prevent oxidative damages, increased intakes from the diet will also reduce the risks of chronic diseases" [1]. This explains the huge volume of research work and the efforts of many researchers to link diets rich in natural antioxidants with degenerative disease.

Apart from their role of health benefactors, antioxidants are added in foods to prevent or delay oxidation of food, initiated by free radicals formed during their exposure to environmental factors such as air, light and temperature [2].

Most of phytochemicals from plant extracts have been identified to exhibit antioxidant activities [3]. Thus many of the biological functions, such as antimutagenicity, anticarcinogenicity, and antiaging, among others, originate from this property [4, 5]. Some of the better-known phytochemicals include: Isoflavones, Anthocyanins, Carotenoids such as lycopene, beta-carotenes [6, 7]

Senecio anteuphorbium, native to Morocco, forms a shrubby plant with many grayish-green upright branches with faint vertical striping. Tapered, fleshy grayish-green leaves are present along the upper half of the stems with whitish-yellow flowers typical of Compositae. The genus *Senecio* (Asteraceae) is widely distributed throughout the World, and is known to be a source of pyrrolizidine alkaloids, eremophilanolides, and furanoeremophilanes [8, 9]. Many *Senecio* species are used in folk medicine as emmenagogues, anti-inflammatory agents and vasodilators [10]. Some other studies reported the antioxidant activity of some *Senecio* species for instance: *Senecio inaequidens* [11], *Senecio gibbosus* [12] and *Senecio stebianus* [13]. Therefore, given the interesting biological properties reported for *Senecio* species. The aim of this study is to investigate for the first time the antioxidant properties by DPPH and FRAP tests of *Senecio anteuphorbium* and to explore relationship between this activity and phenolic, flavonoid and proanthocyanidin content. In addition the effect of two solvents plus heat was evaluated.

2. MATERIAL AND METHODS

2.1 Plant material

The whole plant of *Senecio anteuphorbium* was collected from Sidi Ifni, Southern Anti-Atlas of Morocco and was authenticated by Prof. Laila RHAZI of the Department of Biology, Faculty of Sciences, University of Hassan II Casablanca.

To avoid any contamination or dust, the plant's aerial parts (leaves and stems) were cleaned and spread to dry at room temperature in a clean room.

The arial part

2.2 Preparation of plant extracts

2.1.1 Soxhlet extraction

Powdered sample of *Senecio anteuphorbium* was extracted with methanol using soxhlet system. Extraction was carried out for 16 h at 80°C. The extract was filtered, then concentrated by Rotavapor-R20 (Heidolph Bioblock Scientific) at 40°C.

2.1.2 Decoction

Powdered sample was mixed with distilled water in a round-bottom flask, linked to a column connected to a refrigerant. Then it was placed at 60°C for 1 hour. The decoction extract was filtered using gauze and Whatman No. 1 filter paper and then concentrated by Rotavapor-R20 (Heidolph Bioblock Scientific) at 40°C.

71 **2.1.3 Maceration**

72 Plant material was allowed to stand for 24 hours at room temperature, under shaking in
73 methanol and water separately. After filtration and concentration as described above,
74 methanol and aqueous filtrates were obtained.

75
76 Absorbance was measured using an UV-visible spectrophotometer (Thermo electron
77 corporation, Biomate 3)

78 79 **2.3 Total phenolic content**

80 Total phenolics of various samples were determined by the Folin-Ciocalteu method [14].
81 0.1 ml of sample was combined with 2.8 ml of 10% Na_2CO_3 and 0.1 ml of 2N Folin-ciocalteu
82 reagent. After 40 min absorbance at 725 nm was measured by
83 UV-visible spectrophotometer (Thermo electron corporation, Biomate 3). Total phenolics
84 were determined as milligrams of gallic acid and tannic acid equivalents per gram of sample
85 (GAE mg/gE or TAE/gE) using a standard calibration curve between (0 to 100 $\mu\text{g/ml}$).

86 87 **2.4 Total flavonoid content**

88 Total flavonoid content was determined using the method aluminium trichloride [15]. 1 ml of
89 2 % aluminium trichloride (AlCl_3) in methanol was mixed with the same volume of the extract
90 solution. After 10 minutes, Absorption readings at 415 nm against a blank sample consisting
91 of a 1 ml extract solution with 1 ml methanol or distilled water without AlCl_3 were assessed.
92 The total flavonoid content was determined using a standard curve with quercetin or rutin
93 (0 - 80 $\mu\text{g/ml}$), then expressed as mg of quercetin or rutin equivalents (QE or RE) / g of
94 extract.

95 96 **2.5 Proanthocyanidin Content**

97 Proanthocyanidin content was estimated according to the procedure reported by [16].
98 A volume of 1 ml solution was mixed with 3 ml of 4% vanillin/methanol solution and 1.5 ml
99 hydrochloric acid and the mixture was allowed to stand for 15 min at room temperature. The
100 absorbance at 500 nm was measured and the Proanthocyanidins was expressed as mg
101 catechin equivalents (mg CE/1g dry mass) using a catechin (0-80 $\mu\text{g/ml}$) standard curve.

102 103 **2.6 Reducing Power Activity Assay**

104 The ability of the extracts to reduce Fe^{3+} was assayed by the method of [17]. Briefly, 1 ml of
105 each extract were mixed with 2.5 ml of phosphate buffer
106 (0.2 M, pH 6.6) and 2.5 ml of 1% $\text{K}_3\text{Fe}(\text{CN})_6$. After incubation at 50°C for 25 min, 2.5 ml of
107 10% trichloroacetic acid was added and the mixture was centrifuged at 3000 g for 10 min.
108 Finally, 2.5 ml of the upper layer was mixed with 2.5 ml of distilled water and 0.5 ml of 0.1%
109 aqueous FeCl_3 . The absorbance was measured at 700 nm. The mean of absorbance values
110 were plotted against concentration and a linear regression analysis was carried out.
111 Increased absorbance of the reaction mixture indicated increased reducing power. Ascorbic
112 acid and trolox were used as positive control.

113 114 **2.7 DPPH Radical Scavenging Activity**

115 The free radical scavenging activities of the samples on the DPPH radical were measured
116 using the method described by [18]. A 0.1 ml of various concentrations of each extracts at

different concentrations was added to 3.9 ml of DPPH solution (25 mg/l in methanolic solution). After the mixture was shaken and left at room temperature for 30 min, the absorbance at 517 nm was measured. Lower absorbance of the reaction mixture indicates higher free radical scavenging activity. The IC₅₀ value, defined as the amount of antioxidant necessary to decrease the initial DPPH concentration by 50%, was calculated from the results and used for comparison. The capability to scavenge the DPPH radical was calculated by using the following equation:

$$\text{DPPH scavenging effect (\%)} = [(A_1 - A_2)/A_1] \times 100$$

Where A₁ = the absorbance of the control reaction, A₂ = the absorbance in the presence of the sample. Ascorbic acid and Trolox were used as standards.

3. RESULTS AND DISCUSSION

Total phenolic content ranged between 21.53±1.03 mg GAE/ gE or 20.38±0.76 mg TAE/gE and 2.46±0.11 GAE/ gE or 2.33±0.09 mg TAE/gE (table 1). The highest amount was obtained with methanol when combined with heat followed by decoction; while the lowest value was obtained with aqueous maceration. Plant's polyphenols are very important secondary defense metabolites and protect the plant from infections and give oxidative stabilities in case of injuries [19, 20]. Gallic (a trihydroxybenzoic acid) and tannic acids (a mixture of polyphenols) have different chemical structures, thus most plants are complex mixtures with a large group of compounds (other than polyphenols) such as beer; this may explain the differences in total polyphenol content when using GAE and TAE as reported in some studies [21]. Values obtained with both standards were approximately similar which suggests that gallic acid and tannic acid are both appropriate for this method. It also suggests that *Senecio anteuphorbium* contains rihydroxybenzoic acid as much as polygalloyl glucoses.

Table 1. Total phenolic content of *Senecio anteuphorbium*

Extracts/test	Total phenolic content	
	mg GAE/ gE	mg TAE/gE
MS	21.53±1.03	20.38±0.76
MM	6.92 ± 0.26	6.55±0.45
D	14.56 ±0.95	13.78±0.71
AM	2.46±0.11	2.33±0.09

GAE: gallic acid equivalents, TAE: tannic acid equivalents, gE: g of extract, MS: methanolic Hot Continuous Extraction (Soxhlet). MM: methanol maceration, D: decoction, AM: aqueous maceration. All results are presented as mean ± standard mean error of three assays.

Methanolic extract obtained with soxhlet extraction expressed the highest total flavonoid content: 26.59±0.24 mg QE/gE or 39.47±1.01 mg RE/gE. However aqueous maceration showed the lowest amount: 6.52±0.09 mg QE/gE or 9.68±0.22 mg RE/gE (table 2). Flavonoids have been found to exert a variety of biological effects, they have been shown to accelerate wound healing and protect cultured skin cells and tissues from oxidative damage [22].

164 **Table 2. Total flavonoid content of *Senecio anteuphorbium***

Extracts/test	Total flavonoid content	
	mg QE/gE	mg RE/gE
MS	26.59±0.24	39.47±1.01
MM	13.51 ±0.37	20.05 ± 0.5
D	13.51±0.55	29.05 ±0.78
AM	6.52±0.09	9.68±0.22

165 **QE:** quercetin equivalents, **RE:** rutine equivalents, **g E:** g of extract, **MS:** methanolic hot Continuous
 166 Extraction (Soxhlet). **MM:** methanol maceration, **D:** decoction, **AM:** aqueous maceration.
 167 All results are presented as mean ± standard mean error of three assays.
 168

169 Proanthocyanidins or condensed tannins are polymeric flavonoids. They have received
 170 considerable attention owing to their various biological activities, in particular their oxygen
 171 free radical scavenger ability [23]. Results in table 3, show that the maximum amount of
 172 proanthocyanidins is obtained with methanolic hot continuous extraction (36.66 ±1.26
 173 mgCE/gE).
 174
 175
 176

Table 3. Total proanthocyanidin of *Senecio anteuphorbium*

Extracts	MS	MM	D	AM
Proanthocyanidin (mgCE/gE)	36.66 ±1.26	13.71± 0.05	15.42±0.47	5.8 ± 0.19

177 **CE:** catechins equivalents, **gE:** g of extract, **MS:** methanolic Hot Continuous Extraction (Soxhlet). **MM:**
 178 methanol maceration, **D:** decoction, **AM:** aqueous maceration.
 179 All results are presented as mean ± standard mean error of three assays.
 180

181 Methanolic extract combined with heat exhibited the highest radical scavenging activity with
 182 the lowest IC50 (3.38), compared to standards (table 4); which means that it can scavenge
 183 more free radicals than trolox and vitamin C. The scavenging activity of methanolic and
 184 aqueous maceration was not effective than standars.
 185
 186

Table 4. Antioxidant activity of *Senecio anteuphorbium* DPPH reagent

Extracts and standards	MS	MM	D	AM	Trolox	Vitamin C
IC50 (mg/ml)	3,38	30,7	5,6	39,98	5	3.6
AA	0,287	0,032	0,178	0,025	0,2	0,277

187 **MS:** methanolic Hot Continuous Extraction (Soxhlet). **MM:** methanol maceration, **D:**
 188 decoction, **AM:** aqueous maceration, **AA:** antioxidant activity.
 189 All results are presented as mean ± standard mean error of three assays.
 190

191 The highest capacity in reducing ferric ion (Fe3+) to ferrous ion (Fe2+) was observed in
 192 methanolic extract (soxhlet) followed by decoction. However the weakest abilities to reduce
 193 ferric ion were exhibited by aqueous and methanolic maceration as it's shown in figure 1.
 194

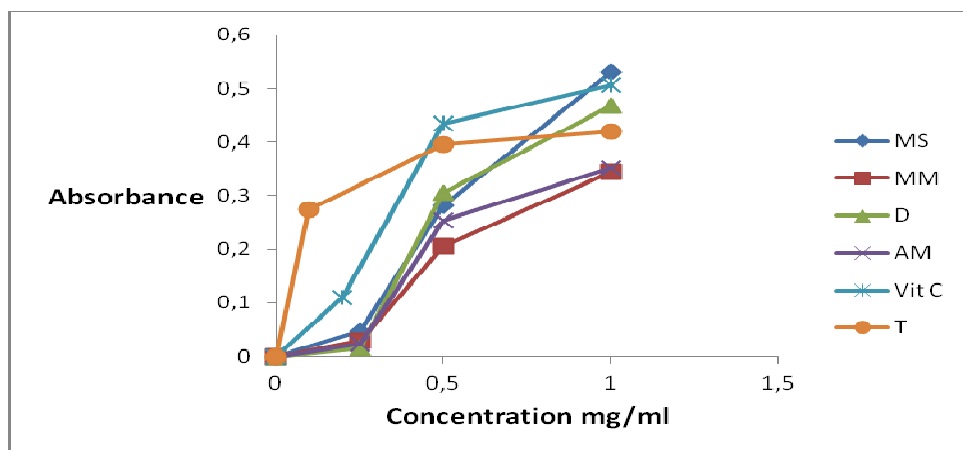


Fig. 1. Reducing power of different extracts of *Senecio anteuphorbium*

MS: methanolic Hot Continuous Extraction (Soxhlet). MM: methanol maceration, D: decoction, AM: aqueous maceration, T: trolox, Vit C: Vitamin C.

The correlation between phenolic, flavonoid, proanthocyanidin compounds and antioxidant activity showed a positive correlation for the two first chemicals showing respectively a $R^2 = 0.96/0.90/0.81$ (figure 2). This indicates the close relationship between total phenolics compounds and antioxidant activity as reported by Prasad *et al* [24] and Lei *et al* [25]. The conception of antioxidant action of phenolic compounds is not novel. Antioxidant action of phenolic compounds is due to their high tendency to chelate metals. Phenolics possess hydroxyl and carboxyl groups, able to bind particularly iron and copper [26].

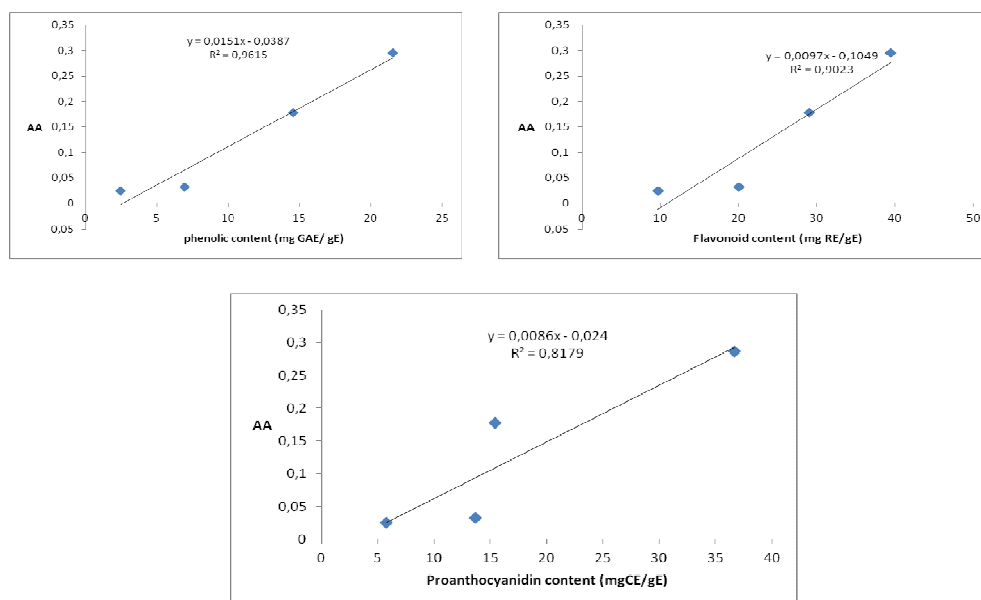


Fig. 2. Correlation between phenolic, flavonoid, proanthocyanidin and AA (antioxidant activity)

4. CONCLUSION

In conclusion, these results show that antioxidant phytochemicals are more extractible by methanol combined with heat which might be due in part to the high polarity and efficacy of methanol, in addition to the increase of temperature and time as it is demonstrated when we compared amounts obtained with decoction (60°C/1 hour) and soxhlet (80°C/16 hours). The present study also suggested that *Senecio anteuphorbium* could be a potential source of natural antioxidants and thus could be useful as therapeutic agents as it showed a high reducing and radical scavenging activity. Further works should include the separation and identification of active components on one hand, and *in vivo* studies of their effect in the other hand.

COMPETING INTERESTS

"Authors have declared that no competing interests exist."

CONSENT (WHERE EVER APPLICABLE)

Not applicable.

ETHICAL APPROVAL (WHERE EVER APPLICABLE)

Not applicable.

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