The Antioxidant Analysis of Selected Types of Climbing Plants with Therapeutic Effect

Original Paper

Hrúzová M.^{1✉}, Mňahončáková E.¹, Šimková J.²

¹Botanical Garden SUA in Nitra,
T. A. Hlinku 2, 949 76 Nitra, Slovakia
²Institute of Biodiversity Conservation and Biosafety,
Faculty of Agrobiological and Food Resources, SUA in
Nitra, T. A. Hlinku 2, 949 76 Nitra, Slovakia

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Abstract Climbing plants with therapeutic effects are relatively little studied group of medicinal species. In the collection of climbing species planted in 2019 in the Botanical Garden of the Slovak University of Agriculture (SUA) in Nitra, we observed the growth and potential food, horticulture and healing use. For the antioxidant analysis, 7 species from 152 plants of 13 genera and 22 species were selected. The highest antiradical activity was recorded in the species *Vigna sinensis*, where reached average measured values achieved up to 73.79%. However, the related species *Vigna unguiculata* achieved only 26% of antioxidant activity. Of the fruits, the highest activity was *Momordica charantia* in immature state (73%). Other fruits showed very low antiradical activity

Keywords Antioxidant activity – climbing plants – fruits – medicinal species – therapeutic effect

INTRODUCTION

In 2019, the Botanical Garden of SUA in Nitra planted a collection of creeping medicinal plants in order to monitor their growth and potential food, horticulture and healing use. All the species were grown from seed obtained as a gift and seed exchanged through the international network *Index seminum*.

The use of climbing medicinal plants is very wide. In addition to their therapeutic function, they are used as decorative liana in outdoor expositions (*Basella* L., *Lablab* Adans., *Ipomoea* L.), but also as food (*Phaseolus* L., *Cyclanthera* Schrad., *Vigna* Savi), oil source (*Lagenaria* Ser.), as washing sponges (*Luffa* Mill.), soap replacement (*Vigna* Savi), vessels and musical instruments (*Lagenaria* Ser.) and other. Vertical vegetation is realized in current plantations either as planting of plants vertically on various constructions or as planting of climbing plants using natural height growth. For food purposes, fruits and seeds are processed in the form of canned products, various sauces or dried. The medicinal effects of these plants are used primarily in folk medicine, but in some cases, also in the pharmaceutical industry.

The selected species are a diverse group of plants in terms of botany. *Cyclanthera pedata* (L.) Schrad, *Diplocyclos palmatus* (L.) C. Jeffrey, *Luffa acutangula* (L.) Roxb., *Momordica*

charantia L. and *Trichosanthes cucumerina* L. belong to family *Cucurbitaceae*. From family *Leguminosae* are *Vigna unguiculata* (L.) Walp. and *Vigna sinensis* (L.) Savi ex Hassk.⁽²³⁾ *Cyclanthera pedata* (L.) Schrad, native to the Andes, are largely used in South America for their anti-inflammatory, hypoglycaemic and hypocholesterolemic properties.⁽¹⁶⁾ Plant chemicals of fruits: phenols, peptin, galacturonic acid, picrin, lipoproteins, flavonoids, glycosides, mucilage, alkaloids, lipids, tannins, terpenes, resins, carbohydrates, sterols, scoparin, vitamins, vitexin, and minerals.⁽²⁴⁾ *Diplocyclos palmatus* (L.) C. Jeffrey is an annual climber with bright red fruit and is reported to be highly medicinal.⁽¹¹⁾ The chloroform and methanolic extracts of aerial parts of this species contained alkaloids, flavonoids, tannins, saponins, diterpenes, triterpenoids, glycosides and steroids.⁽⁴⁾ *Luffa acutangula* (L.) Roxb. is a perennial climber native to southern and western India. It is commonly known as ridge gourd, sponge gourd or angled luffa.⁽¹⁰⁾ In Ayurveda, fruits and seeds of *L. acutangula* used to treat jaundice, biliousness, bronchitis and asthma.⁽¹²⁾ *L. acutangula* has been shown to possess CNS depressant activity,⁽¹⁵⁾ in vitro antioxidant activity⁽³⁾ and larvicidal activity.⁽¹⁷⁾

* E-mail: michaela.becarova@gmail.com

Momordica charantia L. contains biologically active chemicals that include glycosides, saponins, alkaloids, fixed oils, triterpenes, proteins and steroids.⁽¹⁹⁾ Some clinical trials have also confirmed the hypoglycaemic action.⁽¹⁴⁾

Trichosanthes cucumerina L. has been traditionally used as anthelmintic and antipyretic remedies. The root has been used to treat bronchitis and heart disease.⁽¹⁸⁾ The plant is a good source of bioactive compounds such as carotenoids, flavonoids, and phenolic acids and this makes it a suitable antioxidant source.⁽¹⁾

Vigna unguiculata (L.) Walp. is native to tropical Africa, where it still grows wild. It is a prostrate or climbing leguminous plant producing narrow, straight or slightly curved pods, 8–100 cm long, but not exceeding 1 cm in width.⁽⁷⁾ It is a good source of phenolic compounds⁽²⁾ with the potential to protect against chronic diseases including cancer.⁽¹³⁾

Vigna sinensis (L.) Savi ex Hassk. (syn.: *Vigna unguiculata* (L.) Walp.) contain bioactive compounds such as vitamins, carotenoids and phenolic compounds.⁽⁸⁾ The seeds contain phenolic compounds in various forms: hydroxybenzoic and hydroxycinnamic acids, both free and bound to other molecules, as organic acids, in esterified forms.^(8,22,9) Significant variability in seed protein and some of the essential amino acids has been identified in cowpea accessions.⁽²¹⁾

MATERIAL AND METHODS

The assortment of climbing plants with therapeutic effects was obtained in the form of seeds by gift and seed exchange through the international network *Index seminum*. All the analysed species were planted in the Botanical Garden of SUA in 2019. Because most of the species included in the collection originate from tropical and subtropical areas, the grown under protected environment of foil in spring time was suggested. The selected assortment also tolerates outdoor cultivation in our climatic conditions. Regarding the increase in production, but especially sufficient maturation of fruits, analysed plants were planted in a greenhouse. For the antioxidant analysis, the fruits of the following species were selected: *Cyclanthera pedata* (L.) Schrad, *Diplocyclos palmatus* (L.) C. Jeffrey, *Luffa acutangula* (L.) Roxb., *Momordica charantia* L., *Trichosanthes cucumerina* L. var. *anguina*, and ground vine seeds, particularly *Vigna sinensis* (L.) Savi ex Hassk. and *Vigna unguiculata* (L.) Walp. ssp. *sesquipedalis* 'Red Noodl'. In the case of *Trichosanthes* and *Momordica*, we harvested the unripe fruits, the ripened fruits and the tegument. The species *Cyclanthera* and *Luffa* were taken in consumer maturity, in the immature fruits, the species *Diplocyclos* in full maturity. *Vigna* seeds were harvested in both cases after maturation. The harvesting of fruits and seeds took place on 3rd September 2019. The reason for harvesting unripe fruits in some species was their traditional green consumption. For experimental evaluation, 1 g per aqueous solution and 1 g per methanol solution were taken from ground and crushed fruits and seeds.

Antiradical activity was determined by the modified DPPH method of⁽⁵⁾ using a Genesys 20 model 4001/4 spectrophotometer. In principle, it is a reduction of the 2,2-diphenyl-1-picrylhydrazyl (DPPH) stable radical in methanol solution in the presence of antioxidants. This translates into a decrease in absorbance at 515 nm in the dark. The decrease is recorded after 10 minutes of reaction. For the measurement, we used a basic solution of 25 mg DPPH in 100 ml methanol. This is diluted in a ratio of 10 ml to 100 ml of methanol per working solution and this is used to measure the antioxidant activity. 3.9 ml of DPPH solution is pipetted into the cuvette and the absorbance value corresponding to the initial concentration of DPPH solution as A_0 is recorded. Add 0.1 ml of the solution/extract of interest, which is stirred in the cuvette by moving the stirrer upwards and immediately starting the measurement of the dependence of A_t , where $t = 10$ (10 minutes). The efficiency of the extracts is calculated according to the mathematical formula: % inhibition = $[(A_0 - A_{10}) / A_0] \times 100$ (where A_0 is absorbance without extract and A_{10} is absorbance with extract). Inhibition of DPPH radical is the monitored component capable of removing at a given time. The value of antioxidant activity (A_A) was subsequently classified according to the values obtained as: high inhibition > 70 %, average 40–70 % and low < 40 %.

RESULTS AND DISCUSSION

For the antioxidant analysis, 7 species from collection of 22 planted species were selected.

Water and methanol solutions prepared by mixing 1 g of crushed or chopped fruits and seeds with 25 ml of water and 25 ml of methanol were used to analyse the antiradical activity. The values obtained (Table 1) show a low degree of variability in methanol solution in species *Vigna sinensis*, *Vigna unguiculata*, *Momordica charantia* (immature fruit) and *Diplocyclos palmatus*. In water solution, *Vigna sinensis* has shown lowest degrees of variability. Others species has shown moderate degrees of variability (excepting *Cyclanthera pedata* – this one has extremely high coefficient of variation). For all varieties in aqueous solution, we have documented on average lower antioxidant activity compared to methanol solution. The highest values of antioxidant activity were found in *Vigna sinensis* seeds. On average, this is up to 73.79% for methanol solution and 70.06% for aqueous solution. Compared to a similar species of *V. unguiculata*, the measured values were higher by approximately 49% in both solutions. In Nigeria,⁽⁶⁾ they compared the ability to absorb free radicals between different forms of *Vigna unguiculata*. The result revealed that *V. unguiculata* had the average free radical scavenging ability (5.5–30 %). These are comparable results to our measurements. In fruits, the highest activity was found in methanol solution in *Momordica* immature fruits (up to 73 % on average). In contrast, the aqueous solution of *Momordica charantia* showed very low antioxidant activity,

Table 1. The antioxidant activity of selected climbing plants.

Solution	Species	n	min	max	x	s	sx	V%
water	<i>Cyclanthera pedata</i> (ripe fruit)	3	0,54	3,87	1,88	1,76	1,02	93,62
	<i>Diplocyclos palmatus</i> (ripe fruit)	3	6,68	10,26	8,35	1,80	1,04	21,57
	<i>Momordica charantia</i> (immature fruit)	3	2,25	3,11	2,58	0,46	0,27	17,94
	<i>Momordica charantia</i> (ripe fruit)	3	3,07	4,93	3,74	1,03	0,60	27,64
	<i>Momordica charantia</i> (seed coat)	3	8,34	9,89	9,27	0,82	0,47	8,82
	<i>Trichosanthes cucumerina</i> (ripe fruit)	3	1,33	2,38	1,76	0,55	0,32	31,36
	<i>Trichosanthes cucumerina</i> (immature fruit)	3	1,17	2,81	2,05	0,83	0,48	40,48
	<i>Trichosanthes cucumerina</i> (seed coat)	3	5,01	6,23	5,58	0,61	0,35	10,92
	<i>Luffa acutangula</i> (immature fruit)	3	3,23	3,66	3,46	0,22	0,13	6,38
	<i>Vigna sinensis</i> (seed)	3	69,91	70,25	70,06	0,17	0,10	0,25
	<i>Vigna unguiculata</i> 'Red Noodle' (seed)	3	16,67	21,14	19,39	2,39	1,38	12,34
Solution	Species	n	min	max	x	s	sx	V%
methanol	<i>Cyclanthera pedata</i> (ripe fruit)	3	2,17	4,96	3,61	1,40	0,81	38,73
	<i>Diplocyclos palmatus</i> (ripe fruit)	3	14,69	15,22	14,93	0,26	0,15	1,77
	<i>Momordica charantia</i> (immature fruit)	3	2,88	5,33	4,47	1,38	0,80	30,89
	<i>Momordica charantia</i> (ripe fruit)	3	72,62	73,98	73,41	0,71	0,41	0,96
	<i>Momordica charantia</i> (seed coat)	3	2,70	4,44	3,56	0,87	0,50	24,42
	<i>Trichosanthes cucumerina</i> (ripe fruit)	3	2,77	3,59	3,07	0,45	0,26	14,78
	<i>Trichosanthes cucumerina</i> (immature fruit)	3	2,05	3,51	2,60	0,80	0,46	30,61
	<i>Trichosanthes cucumerina</i> (seed coat)	3	3,94	6,11	4,71	1,21	0,70	25,63
	<i>Luffa acutangula</i> (immature fruit)	3	7,03	9,02	7,86	1,03	0,60	13,15
	<i>Vigna sinensis</i> (seed)	3	73,04	75,07	73,79	1,11	0,64	1,50
	<i>Vigna unguiculata</i> 'Red Noodle' (seed)	3	25,16	26,65	25,93	0,74	0,43	2,87

Explanations: n-number of observations, min/max – minimum and maximum value measured in the file (%), x – arithmetic mean of the set, s – standard deviation, V% - coefficient of variation (%).

only 3.74 % on average. In a study⁽²⁰⁾ from Taiwan, stronger DPPH radical scavenging activity was demonstrated in aqueous solution than in ethanol solution. However, dry fruits were used in this study.

In other samples, we found only very low antioxidant activity, on average below 10 %.

In the statistical evaluation, the high coefficient of variation of *Cyclanthera pedata* is interesting, when we found an extremely high degree of variability (93.62%) in aqueous solution. For the methanol solution, the coefficient of variation of this species was moderately high – 38.73%.

Surprising values were achieved by *Trichosanthes*, where in all variants only a low ability to bind radicals was found. It is worth mentioning, however, the high proportion of water in fruits of this kind, which apparently contributed to the measured values. In the future, it will be interesting to compare the achieved results with dried fruits, where we anticipate higher values of antiradical activity. In *Trichosanthes cucumerina*,

there is even a difference in antioxidant activity between morphotypes⁽¹⁾ within this species.

CONCLUSION

Chosen species for antioxidant analysis were very different in results. Of the 7 analysed species, *Vigna sinensis* seeds showed the highest antioxidant activity. In fruits, the samples were based on fresh fruits. This had, probably a great effect on the results of antioxidant activity.

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