

Studies on Anticholinesterase and Antioxidant Effects of Samples from *Colchicum* L. Genus of Turkish Origin

Duygu Sevim was awarded the Young Scientist prize of FABAD for her article

Duygu SEVİM^{*o}, Fatma Sezer SENOL^{*}, Esin BUDAKOĞLU^{*}, Ilkay ERDOĞAN ORHAN^{*}, Bilge SENER^{*}, Erdal KAYA^{**}

Studies on Anticholinesterase and Antioxidant Effects of Samples from Colchicum L. Genus of Turkish Origin

Türkiye’de Yetişen Colchicum L. Cinsine Ait Örneklerin Antikolinesteraz ve Antioksidan Etkileri Üzerine Çalışmalar

Summary

Colchicum L. (Liliaceae) species known as “Acıçığdem” in Turkish, are an old world genus of about 99 species mainly distributed in the Mediterranean region. In Turkey, there are about 49 taxon along with new species collected from 81 populations¹. The bulbs and seeds have medicinal value and the compound colchicine is prepared from them².

Continuing our studies on the screening of cholinesterase inhibitory activity of geophytes, the methanol extracts prepared from the bulbs and seeds of *Colchicum* samples have been investigated for their cholinesterase inhibitory activity against acetylcholinesterase (AChE) and butyrylcholinesterase (BChE), the enzymes linked to Alzheimer’s disease, at 200 µg mL⁻¹ using ELISA microplate reader in this study. Antioxidant activity of the extracts has also been measured by radical scavenging activity test against 2,2-diphenyl-1-picrylhydrazyl (DPPH) at 2000 µg mL⁻¹. Among all tested samples, the methanol extract of *C. variegatum* has been found as moderate activity (35.50 ±2.26%) against AChE, most of the extracts have no activity. However, two extracts of *C. crocifolium* (82.73 ±1.88%) and *C. variegatum* (67.71 ±2.79%) have shown significant activities against BChE. On the other hand, all of the extracts displayed low profile of DPPH scavenging effect below 40%.

Özet

Türkçe’de ‘Acıçığdem’ olarak bilinen *Colchicum* L. (Liliaceae) türleri, genel olarak Akdeniz bölgesinde tanımlanan, yaklaşık 99 tür içerisinde eski bir dünya cinsidir. 81 popülasyondan toplanmış yeni türlerle birlikte Türkiye’de 49 taksonu vardır¹. Soğanlar ve tohumlar içerdikleri kolşisin bileşiği nedeniyle ilaç değeri taşımaktadır².

Geofitlerin kolinesteraz inhibitör aktiviteleri açısından yapılan tarama çalışmalarımız sırasında, *Colchicum* örneklerinin soğanlarından ve tohumlarından hazırlanan metanollü ekstratler, Alzheimer hastalığı ile ilgili enzimler olan asetilkolinesteraz (AChE) ve butirilkolinesteraza (BChE) karşı kolinesteraz inhibitör aktiviteleri yönünden 200 µg mL⁻¹ konsantrasyonda ELISA mikroplak okuyucu kullanılarak araştırılmıştır. Ekstrelerin antioksidan aktiviteleri 2000 µg mL⁻¹ konsantrasyonda 2,2-difenil-1-pikrilhidrazil (DPPH) süpürücü aktivitesiyle ölçülmüştür. Asetilkolinesteraza karşı çoğu ekstratler aktivite göstermezken, bütün test örnekleri arasında *C. variegatum* (%35.50 ±2.26) ‘un metanollü ekstratlerinin orta derecede aktivitesi tespit edilmiştir. *C. crocifolium* (%82.73 ±1.8) ve *C. variegatum* (%67.71 ±2.79) butirilkolinesteraza karşı belirgin bir aktivite göstermiştir. Bunun yanısıra, bütün ekstratlerin %40’ın altında DPPH süpürücü aktiviteye sahip oldukları saptanmıştır.

Key Words: *Colchicum*, Acetylcholinesterase, Butyrylcholinesterase, Antioxidant, Activity.

Anahtar Kelimeler: *Colchicum*, Asetilkolinesteraz, Butirilkolinesteraz, Antioksidan, Aktivite.

Received: 15.06.2012

Revised: 20.06.2012

Accepted: 25.06.2012

* Department of Pharmacognosy, Faculty of Pharmacy, Gazi University, Ankara, Turkey

** Atatürk Central Horticultural Research Institute, Yalova, Turkey

o Corresponding Author E-mail: duyguvm@gmail.com

INTRODUCTION

Colchicum L. (Liliaceae) species are known as 'Acicigdem' in Turkey. Turkish species are divided into two groups as spring flowering and autumn flowering species¹.

Plants of genus *Colchicum* have intrigued many investigators for more than 2000 years for their marked medicinal and other biological properties. Today colchicine, the main alkaloid, is still the drug of choice to cure acute gout attacks and Familial Mediterranean Fever (FMF) attacks. Colchicine and its natural analogues have been used in biological and breeding studies to produce polyploidy or multiplication of the chromosomes in the cell nucleus².

The major phenolic compounds obtained from the genus, *Colchicum*, are 4-hydroxy-3-methoxybenzaldehyde (vanilin), 4-hydroxybenzoic acid (vanillic acid), 3-(3-hydroxyphenyl)-2-propanoic acid (coumaric acid), 3-(3, 4-dihydroxyphenyl)-2-propanoic acid (caffeic acid) and 3, 4, 5, 7-tetrahydroxyflavone (luteolin)³.

MATERIALS and METHODS

Bulbs and seeds of samples belonging to 49 *Colchicum* taxon were collected from different regions of Turkey by Erdal Kaya. They were identified by Prof. Dr. Neriman Özhatay (İstanbul) and Dr. Karin Persson (Sweden). Voucher specimens are kept in the Herbarium of Atatürk Central Horticultural Research Institute. Air dried plant materials were powdered and extracted with methanol at room temperature in the dark, since the colchicine transforms into lumi-colchicine.

AChE and BChE inhibitions, were determined by using Ellman method⁴. This is a spectrophotometric and quantitative method, which is useful for highthroughput screening assays. Extracts were investigated for their *in vitro* cholinesterase inhibitory activity at 200 µg ml⁻¹ using ELISA microplate reader. Galanthamine (Sigma), is a natural molecule and a patented drug isolated from *Galanthus nivalis*, was used as the reference drug. 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging effect

(antioxidant activity) of the extracts was also tested at 2000 µg ml⁻¹ final concentrations by ELISA microplate reader⁵. Gallic acid was used as reference for antioxidant activity.

RESULTS

AChE and BChE inhibitions and DPPH radical scavenging activities of *Colchicum* samples have given on the Tables 1, 2, 3 and 4.

Among methanol extracts of *Colchicum* samples, only five extracts showed AChE inhibitory activity. The most active one was *C. variegatum* (seed, 35.50 ±2.26%). However, it had no significant activity according to galantamine (reference). *Colchicum balansae*, *C. atticum*, *C. stevenii* and *C. umbrosum* showed very low activity (below 12%) and the other extracts had no activity against AChE (Table 1, 2, 3, 4).

Methanol extracts of *C. crocifolium* was the most active sample against BChE. The seed extracts of *C. variegatum* (67.71 ±2.79%) and *C. balansae* (44.22 ±2.46%) and also the bulb extracts of *C. hirsutum* (59.89 ±0.79%), *C. figlalii* (33.09 ±0.88%) and *C. szovitsii* ssp. *branchyphyllum* (33.01 ±1.50%) had significant activities. Among the extracts, 7 of them had no activity against BChE (Tables 1, 2, 3, 4).

All of the extracts displayed low effect of DPPH below 40% (Tables 1, 2, 3 and 4).

DISCUSSION

Two species (*C. balansae*, *C. speciosum*) among the ones we examined in this report were mentioned to have insignificant antioxidant activities. This finding is consistent with our results^{6,7}.

CONCLUSIONS

In our study, 104 *Colchicum* samples were investigated for their cholinesterase inhibitory activities against acetylcholinesterase (AChE) and butyrylcholinesterase (BChE), the enzymes linked to Alzheimer's disease, at 200 µg mL⁻¹ using ELISA microplate reader. Antioxidant activities of the extracts were also measured by radical scavenging activity test against 2,2-diphenyl-1-picrylhydrazyl

Table 1. AChE/BChE inhibitory and DPPH radical scavenging activity of the methanol extracts of *Colchicum taxa* (Percentage \pm S.E.M*) – 1

Analysis Codes	Species	Population No	AChE Inhibition Activity (Percentage \pm S.E.M.*)	BChE Inhibition Activity (Percentage \pm S.E.M.)	DPPH Radical Scavenging Activity (Percentage \pm S.E.M.)
			200 μ g/ml	200 μ g/ml	2000 μ g/ml
C-78	<i>Colchicum antepense</i> K. Perss	C2705A	–**	21.47 \pm 2.53	2.79 \pm 0.39
C-35	<i>C. atticum</i> (Spruner) Boiss. & Spruner	C0601	-	10.23 \pm 1.86	14.91 \pm 3.06
C-118	<i>C. atticum</i> (Spruner) Boiss. & Spruner (seed)	C1406	4.72 \pm 1.32	13.72 \pm 0.79	12.91 \pm 1.16
C-14	<i>C. balansae</i> K. Perss.	C4803	-	13.01 \pm 3.61	13.18 \pm 1.54
C-1	<i>C. balansae</i> K. Perss.	C4205	-	26.30 \pm 2.71	9.51 \pm 3.14
C-107	<i>C. balansae</i> K. Perss. (seed)	C4809	10.90 \pm 1.17	44.22 \pm 2.46	16.72 \pm 2.87
C-2	<i>C. baytopiorum</i> C. D. Brickell	C1502A	-	21.41 \pm 3.15	13.62 \pm 2.18
C-27	<i>C. baytopiorum</i> C. D. Brickell (seed)	C0719	-	16.85 \pm 1.30	7.29 \pm 2.95
C-3	<i>C. bivonae</i> Guss.	C1416	-	5.36 \pm 0.94	11.91 \pm 2.68
C-30	<i>C. bivonae</i> Guss. (seed)	C1416	-	24.41 \pm 4.66	9.37 \pm 0.87
C-23	<i>C. bivonae</i> Guss.	C3401	-	14.10 \pm 1.49	10.09 \pm 0.58
C-102	<i>C. bivonae</i> Guss. (seed)	C1701	-	-	4.70 \pm 2.63
C-51	<i>C. boissieri</i> Orph.	C3503	-	1.76 \pm 0.28	5.12 \pm 1.32
C-4	<i>C. boissieri</i> Orph.	C4502	-	20.69 \pm 3.35	4.99 \pm 0.76
C-44	<i>C. burttii</i> Meikle	C2002	-	-	-
C-6	<i>C. chalconicum</i> Azn. ssp. <i>punctatum</i> K. Perss.	C7701	-	17.84 \pm 1.52	14.02 \pm 2.60
C-42	<i>C. chalconicum</i> Azn. ssp. <i>punctatum</i> K.Perss.	C0901	-	18.72 \pm 1.36	7.35 \pm 3.13
C-54	<i>C. chlorobasis</i> K. Perss.	C4220A	-	19.02 \pm 0.30	8.06 \pm 0.87
C-73	<i>C. cilicicum</i> (Boiss.) Dammer	C3304	-	14.32 \pm 1.36	7.56 \pm 2.61
C-101	<i>C. cilicicum</i> (Boiss.) Dammer (seed)	C0103	-	17.22 \pm 4.12	10.32 \pm 0.36
C-60	<i>C. crocifolium</i> Boiss.	C6305	-	82.73 \pm 1.88	5.70 \pm 1.59
C-8	<i>C. davisii</i> C. D. Brickell	C8007	-	23.62 \pm 3.26	19.00 \pm 2.63
C-117	<i>C. davisii</i> C. D. Brickell (seed)	C 4610	-	28.91 \pm 0.16	16.00 \pm 3.78
REFERENCES					
Galantamine		100 μ g/ml	95.78 \pm 4.07	58.69 \pm 1.65	NT***
Gallic acid		1000 μ g/ml	NT	NT	92.07 \pm 0.10

* Standard error mean (n = 3), ** No activity, *** Not tested

Table 2. AChE/BChE inhibitory and DPPH radical scavenging activity of the methanol extracts of *Colchicum taxa* (Percentage \pm S.E.M*) – 2

Analysis Codes	Species	Population No	AChE Inhibition Activity (Percentage \pm S.E.M.)	BChE Inhibition Activity (Percentage \pm S.E.M.)	DPPH Radical Scavenging Activity (Percentage \pm S.E.M.)
			200 μ g/ml	200 μ g/ml	2000 μ g/ml
C-39	<i>C. decaisnei</i> K. Perss.	C0731	-**	5.60 \pm 0.49	7.99 \pm 1.20
C-37	<i>C. decaisnei</i> K. Perss.	C0704A	-	-	-
C-108	<i>C. decaisnei</i> K. Perss. (seed)	C0703	-	24.85 \pm 1.70	12.50 \pm 1.90
C-40	<i>C. dolichantherum</i> K. Perss.	C0738	-	3.97 \pm 2.14	7.53 \pm 0.79
C-83	<i>C. dolichantherum</i> K. Perss.	C0723	-	9.73 \pm 1.07	6.27 \pm 2.44
C-56	<i>C. figlalii</i> (Ö. Varol) Parolly & Eren	C4817	-	33.09 \pm 0.88	29.00 \pm 2.45
C-9	<i>C. heldreichii</i> K. Perss	C4204	-	29.64 \pm 0.85	7.46 \pm 2.11
C-45	<i>C. hirsutum</i> K. Perss	C2302	-	6.49 \pm 0.40	3.74 \pm 0.29
C-79	<i>C. hirsutum</i> K. Perss	C2301	-	59.89 \pm 0.79	9.70 \pm 2.14
C-61	<i>C. ignescens</i> K. Perss	C6307	-	8.19 \pm 2.94	6.45 \pm 0.85
C-10	<i>C. imperatoris-friderici</i> Siehe ex K. Perss.	C3310	-	18.50 \pm 2.55	18.45 \pm 1.44
C-106	<i>C. imperatoris-friderici</i> Siehe ex K. Perss. (seed)	C3310	-	4.85 \pm 0.10	11.63 \pm 1.40
C-11	<i>C. inundatum</i> K. Perss.	C4213	-	10.27 \pm 1.21	15.44 \pm 1.94
C-12	<i>C. kotschyi</i> K. Perss.	C4608	-	13.54 \pm 2.05	16.02 \pm 2.40
C-43	<i>C. kotschyi</i> K. Perss.	C1305	-	-	-
C-29	<i>C. kotschyi</i> K. Perss. (seed)	C1305	-	16.17 \pm 1.65	8.03 \pm 0.46
C-105	<i>C. kotschyi</i> K. Perss. (seed)	C1301	-	19.29 \pm 0.75	9.31 \pm 1.60
C-71	<i>C. lagotum</i> K. Perss.	C2507	-	26.34 \pm 3.62	11.35 \pm 1.95
C-41	<i>C. leptanthum</i> K. Perss.	C0807	-	8.46 \pm 1.26	5.78 \pm 0.31
C-13	<i>C. lingulatum</i> Boiss. & Spruner	C4804	-	15.61 \pm 0.72	11.96 \pm 3.18
C-82	<i>C. macrophyllum</i> B. L. Burt	C4819	-	8.54 \pm 2.43	10.72 \pm 1.10
C-34	<i>C. manissadjanii</i> K. Perss.	C0504	-	9.43 \pm 0.63	10.22 \pm 0.79
C-52	<i>C. micaceum</i> K. Perss.	C3504	-	21.24 \pm 1.16	4.77 \pm 2.71
C-50	<i>C. micranthum</i> Boiss.	C3404	-	7.37 \pm 1.39	11.38 \pm 2.04
C-36	<i>C. minutum</i> K. Perss.	C0702	-	1.16 \pm 0.38	15.07 \pm 4.12
C-58	<i>C. munzurense</i> K. Perss.	C6202	-	13.45 \pm 2.51	9.68 \pm 0.15
C-33	<i>C. paschei</i> K. Perss.	C0205	-	1.60 \pm 0.40	4.56 \pm 0.76
C-48	<i>C. persicum</i> Baker	C2702	-	16.55 \pm 2.29	6.98 \pm 0.83
C-49	<i>C. persicum</i> Baker	C2705	-	8.50 \pm 2.60	5.83 \pm 1.33
C-59	<i>C. persicum</i> Baker	C6304	-	9.74 \pm 1.94	4.42 \pm 1.02
C-111	<i>C. persicum</i> Baker (seed)	C2702	-	23.83 \pm 1.30	11.98 \pm 0.58
REFERENCES					
Galantamine	100 μ g/ml		95.78 \pm 4.07	58.69 \pm 1.65	NT***
Gallic acid	1000 μ g/ml		NT	NT	92.07 \pm 0.10

* Standard error mean (n = 3), ** No activity, *** Not tested

Table 3. AChE/BChE inhibitory and DPPH radical scavenging activity of the methanol extracts of *Colchicum taxa* (Percentage \pm S.E.M*) – 3

Analysis Codes	Species	Population No	AChE Inhibition Activity (Percentage \pm S.E.M.*)	BChE Inhibition Activity (Percentage \pm S.E.M.)	DPPH Radical Scavenging Activity (Percentage \pm S.E.M.)
			200 μ g/ml	200 μ g/ml	2000 μ g/ml
C-15	<i>C. polyphyllum</i> Boiss. & Heldr.	C4603	-**	24.13 \pm 1.53	12.79 \pm 0.37
C-104	<i>C. polyphyllum</i> Boiss. & Heldr. (seed)	C7901	-	19.35 \pm 0.87	14.31 \pm 3.39
C-62	<i>C. raddeanum</i> K. Perss.	C6504	-	14.58 \pm 2.76	10.82 \pm 2.47
C-65	<i>C. raddeanum</i> K. Perss.	C6510	-	10.07 \pm 3.09	8.19 \pm 1.64
C-16	<i>C. sanguicolle</i> K. Perss.	C0717	-	5.37 \pm 3.26	16.11 \pm 1.55
C-17	<i>C. sanguicolle</i> K. Perss.	C0713	-	19.99 \pm 1.39	17.86 \pm 0.82
C-18	<i>C. serpentinum</i> K. Perss.	C7002	-	14.11 \pm 0.56	17.02 \pm 2.27
C-46	<i>C. serpentinum</i> K. Perss.	C2403	-	-	3.23 \pm 0.59
C-66	<i>C. serpentinum</i> K. Perss.	C7003	-	19.20 \pm 0.80	10.68 \pm 0.89
C-67	<i>C. serpentinum</i> K. Perss.	C7009	-	19.52 \pm 1.68	4.19 \pm 2.47
C-68	<i>C. serpentinum</i> K. Perss.	C7010	-	12.34 \pm 3.31	12.03 \pm 1.47
C-55	<i>C. serpentinum</i> K. Perss.	C4401	-	12.91 \pm 0.32	4.81 \pm 0.77
C-116	<i>C. serpentinum</i> K. Perss. (seed)	C1504	-	23.86 \pm 0.54	11.62 \pm 0.21
C-81	<i>C. siehanum</i> Hausskn. ex Stef.	C3311	-	10.14 \pm 0.95	5.68 \pm 1.76
C-26	<i>C. soboliferum</i> C. A. Meyer apud Fisc. & Mey.	C1503	-	5.76 \pm 0.33	12.89 \pm 3.06
C-63	<i>C. soboliferum</i> C. A. Meyer apud Fisc. & Mey.	C6506	-	21.99 \pm 1.32	28.83 \pm 1.25
C-115	<i>C. soboliferum</i> C. A. Meyer apud Fisc. & Mey. (seed)	C1503	-	17.90 \pm 1.65	11.31 \pm 2.50
C-19	<i>C. speciosum</i> K. Perss.	C0801	-	4.93 \pm 1.20	19.38 \pm 0.56
C-5	<i>C. speciosum</i> K. Perss.	C3701	-	16.94 \pm 2.83	8.74 \pm 1.05
C-31	<i>C. speciosum</i> K. Perss. (seed)	C3701	-	16.27 \pm 3.78	7.57 \pm 1.35
C-110	<i>C. speciosum</i> K. Perss. (seed)	C2904	-	15.18 \pm 3.92	-
C-120	<i>C. stevenii</i> Kunth. (seed)	C0716	8.07 \pm 3.69	21.43 \pm 2.80	9.65 \pm 0.70
C-20	<i>C. stevenii</i> Kunth.	C0712	-	21.54 \pm 1.33	12.50 \pm 1.90
REFERENCES					
Galantamine	100 μ g/ml		95.78 \pm 4.07	58.69 \pm 1.65	NT***
Gallic acid	1000 μ g/ml		NT	NT	92.07 \pm 0.10

* Standard error mean (n = 3), ** No activity, *** Not tested

Table 4. AChE/BChE inhibitory and DPPH radical scavenging activity of the methanol extracts of *Colchicum taxa* (Percentage \pm S.E.M*) – 4

Analysis Codes	Species	Population No	AChE Inhibition Activity (Percentage \pm S.E.M.*)	BChE Inhibition Activity (Percentage \pm S.E.M.)	DPPH Radical Scavenging Activity (Percentage \pm S.E.M.)
			200 μ g/ml	200 μ g/ml	2000 μ g/ml
C-64	<i>C. szovitsii</i> K. Perss.	C6507	-**	10.77 \pm 1.52	14.15 \pm 2.10
C-32	<i>C. szovitsii</i> K. Perss. (seed)	C6507	-	11.39 \pm 1.12	12.16 \pm 0.58
C-21	<i>C. szovitsii</i> K. Perss.	C3205	-	23.21 \pm 0.22	11.61 \pm 1.43
C-74	<i>C. szovitsii</i> K. Perss.	C4303	-	9.54 \pm 1.14	3.44 \pm 1.05
C-57	<i>C. szovitsii</i> Fisch. et Mey. ssp. <i>branchyphyllum</i> K. Perss.	C4901	-	23.06 \pm 2.19	14.96 \pm 3.56
C-72	<i>C. szovitsii</i> Fisch. et Mey. ssp. <i>branchyphyllum</i> K. Perss.	C2704	-	33.01 \pm 1.50	10.04 \pm 1.46
C-113	<i>C. szovitsii</i> Fisch. et Mey. ssp. <i>branchyphyllum</i> K. Perss. (seed)	C0202	-	18.12 \pm 0.08	18.23 \pm 1.53
C-47	<i>C. szovitsii</i> Fisch. et Mey. ssp. <i>szovitsii</i>	C2501	-	-	-
C-112	<i>C. szovitsii</i> Fisch. et Mey. ssp. <i>szovitsii</i> Batı (seed)	C2605	-	15.89 \pm 2.11	7.62 \pm 0.67
C-114	<i>C. szovitsii</i> Fisch. et Mey. ssp. <i>szovitsii</i> Doğu (seed)	C2501	-	31.34 \pm 2.89	17.46 \pm 2.10
C-69	<i>C. triphyllum</i> K. Perss.	C7101	-	19.12 \pm 1.39	10.72 \pm 0.54
C-75	<i>C. trigynum</i> (Steven ex Adam) Stapf	C2509	-	21.92 \pm 0.75	7.35 \pm 1.47
C-76	<i>C. trigynum</i> (Steven ex Adam) Stapf	C6501	-	14.36 \pm 3.64	11.10 \pm 2.08
C-22	<i>C. triphyllum</i> G. Kunze	C4203	-	25.50 \pm 1.89	11.08 \pm 2.39
C-70	<i>C. turcicum</i> Janka	C2201	-	17.83 \pm 3.46	10.96 \pm 2.27
C-103	<i>C. turcicum</i> Janka (seed)	C2201	-	2.06 \pm 0.71	3.74 \pm 0.61
C-24	<i>C. umbrosum</i> Steven	C1409	-	6.90 \pm 1.08	13.96 \pm 0.57
C-28	<i>C. umbrosum</i> Steven (seed)	C0804	-	7.28 \pm 0.87	6.61 \pm 0.70
C-121	<i>C. umbrosum</i> Steven (seed)	C6004	11.04 \pm 2.81	13.62 \pm 1.57	8.22 \pm 3.26
C-25	<i>C. variegatum</i> L.	C4204	-	-	7.05 \pm 0.60
C-38	<i>C. variegatum</i> L.	C0715	-	14.02 \pm 1.92	2.65 \pm 1.28
C-122	<i>C. variegatum</i> L. (seed)	C0902	35.50 \pm 2.26	67.71 \pm 2.79	36.35 \pm 2.99
C-7	<i>Colchicum</i> sp.	C5103	-	17.13 \pm 1.67	27.70 \pm 2.84
C-53	<i>Colchicum</i> sp.	C4217	-	12.16 \pm 1.30	10.08 \pm 1.73
C-77	<i>Colchicum</i> sp. (new)	C2404	-	19.28 \pm 4.94	7.89 \pm 1.38
C-80	<i>Colchicum</i> sp. (new)	C3102	-	10.37 \pm 0.93	3.11 \pm 1.12
C-84	<i>Colchicum</i> sp. (new)	C0737	-	12.69 \pm 1.32	7.98 \pm 1.24
REFERENCES					
Galantamine	100 μ g/ml		95.78 \pm 4.07	58.69 \pm 1.65	NT***
Gallic acid	1000 μ g/ml		NT	NT	92.07 \pm 0.10

* Standard error mean (n = 3), ** No activity, *** Not tested

(DPPH) at 2000 µg mL⁻¹. This is the first study describing anticholinesterase effects and antioxidant activities containing all *Colchicum* L. species grown in Turkey.

Among tested samples, no extracts showed remarkable antioxidant activity at concentration of 2000 µg ml⁻¹ for DPPH. From *Colchicum* L. samples, the methanol extract of *C. variegatum* was found as moderate activity (35.50 ±2.26%) against AChE, most of the extracts have no activity. However, two extracts of *C. crocifolium* (82.73 ±1.88%) and *C. variegatum* (67.71 ±2.79%) showed significant activities against BChE.

ACKNOWLEDGEMENTS

Turkish Scientific and Technological Research Council (TÜBİTAK) for financial source (Project code: KAMAG-110G007) was kindly acknowledged.

REFERENCES

1. Kaya, E., *Colchicum* L. in Türkiye'nin Doğal Süs Bitkileri Kataloğu (Kaya, E. ed.), pp. 11-80, Tasarım Matbaacılık Hizmetleri. Yalova (2009)
2. Ahmad, B., Antioxidant Activity and Phenolic Compounds from *Colchicum luteum* Baker (Liliaceae), *African Journal of Biotechnology*, 9 (35), 5762-5766, 2010
3. Al-Mahmoud, M. S. et al., Phytochemical Study and Citotoxicity Evaluation of *Colchicum stevenii* Kunth (Colchicaceae): A Jordanian Meadow Saffron, *Natural Product Research*, 20 (2), 153-160, 2006
4. Ellman, G. L., Courtney, K. D., Andres V., Featherstone R.N., A new and Rapid Colorimetric Determination of Acetylcholinesterase Activity, *Biochemistry and Pharmacology*, 7:88-95, 1961
5. Blois, M. S., Antioxidant Determinations by the Use of a Stable Free Radical, *Nature*, 181, 1199-1200, 1958
6. Ebrahimzadeh, M. A., Nabavi, S. M., Nabavi, S. F., Bahramian, F., Bekhradnia, A. R., Antioxidant and free radical scavenging activity of *H. officinalis* L. var. *angustifolius*, *V. odorata*, *B. hyrcana* and *C. speciosum*, *Pakistan Journal of Pharmaceutical Sciences*, 23 (1), pp. 29-34, 2010
7. Mammadov, R., Düşen, O., Uysal, D., Köse, E., Antioxidant and antimicrobial activities of extracts from tubers and leaves of *Colchicum balansae* Planchon, *Journal of Medicinal Plants Research*, 3 (10), pp. 767-770, 2009

