World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

Check for updates

Enzyme inhibitory effects, antioxidant properties, minerals and essential oils of *Polygonum afyonicum*

Aksoy L *

Afyon Kocatepe University, Faculty of Science and Arts, Department of Chemistry, 03200, Afyonkarahisar, Turkey.

World Journal of Advanced Research and Reviews, 2023, 20(03), 492–502

Publication history: Received on 20 September 2023; revised on 01 November 2023; accepted on 03 November 2023

Article DOI: https://doi.org/10.30574/wjarr.2023.20.3.2118

Abstract

Total phenolic content, total antioxidant capacity, radical scavenging activity, prominent enzyme inhibitory properties, bioelement concentration and fatty acid content were determined qualitatively and quantitatively. methanol and acetone extracts of *Polygonum afyonicum*. The DPPH radical scavenging effect of the plant was found to be significantly different ($p<0.05$) than the synthetic antioxidant butylated hydroxy toluene in the acetone extract with total phenolic content. The total antioxidant capacity of the acetone extract was higher than the methanolic extract total antioxidant status. The enzyme-inhibiting properties of acetone extract are also exceptionally high. It was found to inhibit acetylcholine esterase (86.97±3.76%) and exhibited inhibition activity as much as the standard substance galantamine (87.78±2.59%). In addition, it is seen that the tyrosinase enzyme inhibiting effect is high. Among the determined bioelements, those with the highest concentrations are Ca, K and Mg. It also contains elements (Cu, Fe, Mn and Zn) which are included in the antioxidant enzyme structure. Palmitic acid (42.5%), 1-octadecanol (9.2%) and myristic acid (7.1%) were found the most in the content of essential fatty acids and components. As a result, it was determined that the acetone extract of *Polygonum afyonicum* showed more antioxidative properties. The species is also prominent with its neurodegenerative effects. In addition, there is a need for structural illumination studies to reveal the metabolites responsible for biological activity by determining the phytochemicals contained in the species

Keywords: *Polygonum afyonicum*; Antioxidant; Essential oil; Bio-element; Enzyme inhibition

1. Introduction

Plants are frequently used due to their phytotherapeutic properties as well as their use as nutrients. Plants contain essential nutrients and primary metabolites such as carbohydrates, proteins, fats, vitamins and minerals. Generally, intermediates of primary metabolism are precursors in the formation of secondary metabolites. These are compounds synthesized against natural living conditions such as bacteria, viruses, fungi, nematodes, mites, mammals, animals, and natural living conditions such as climate and soil composition. The plant cell may not only use all the available carbon for primary metabolism but also for the formation of secondary metabolites. There are many different secondary metabolites consisting of terpenes, phenolic compounds, nitrogenous compounds and their derivatives [1, 2]. There are many studies on replacing synthetic substances due to their natural biological activity. Enzymes are biological catalysts that speed up chemical reactions in metabolism. Compounds that cause the activities of enzymes to be reduced or even destroyed by some compounds are called inhibitors. Inhibitors are usually compounds or ions with small molecular weights. Many drugs and toxic compounds exert their effects by inhibiting enzymatic activity. Therefore, it is an important event as it constitutes a control mechanism in biological systems [3, 4].

Polygonum afyonicum is an endemic species in the form of a small bush that grows in forest clearings at an altitude of 1500 m. It is a long, thin plant with a stem length of 21-32 cm [5, 6]. It was aimed to determine inhibitory effects to the

* Corresponding author: Aksoy L.

α-amylase, α-glucosidase, acetylcholine esterase, tyrosinase enzymes and total phenolic content, the total antioxidant status, DPPH free radical scavenging activity of *P. afyonicum* methanol and acetone extracts, which have been studied in limited numbers before. In addition, the biolements and essential fatty acids content were determined in this study.

2. Materials and Methods

Polygonum afyonicum plant samples were collected during the flowering period from Akdağ (38°21'17"N 30°1'5"E), Sandıklı, Afyonkarahisar. Aerial parts of *P. afyonicum* were separated from dust, dirt, pests and contaminations. The plant material was dried using the shade drying method. The dried plant was completely pulverized and the sample taken was extracted with the selected solvents acetone and methanol for about 24 hours using the Soxhlet device. It was centrifuged at 3000 rpm at the end of the extraction process. The extracts were filtered and evaporated at approximately 40°C under vacuum until the solvent was completely removed. *Polygonum afyonicum* methanol extract (PAM) and *Polygonum afyonicum* acetone extract (PAA) were kept at +4 °C.

2.1. Determination of Antioxidative Effects

2.1.1. DPPH Radical Scavenging Effect

2,2-Diphenyl-1-picrylhydrazyl (DPPH) was used for the antiradicalic activity of the extracts. The extracts prepared at different concentrations. Free radical was put into them. The sample and control's absorbances were measured at 517 nm. The free radical inhibition rates of the extracts and the IC_{50} values, which is the concentration at which 50% of the radical is inhibited, were calculated for each extract by using the absorbance values [7].

2.1.2. Total Phenolic Substance Amount

It was determined according to the Folin-Ciocalteu method. Gallic acid was used as the standard. Extract and Folin-Ciocalteu reagent were mixed and kept. It was added saturated Na_2CO_3 solution. The absorbance was read at 760 nm. The standard curve was drawn according to gallic acid. The results were presented as mg GAE (gallic acid equivalents)/g extract [8].

2.1.3. Total Antioxidant Status

Total antioxidant status was determined with kits (Rel Assay, Gaziantep, Turkey). The oxidation of $ABTS^+$ **(**2,2-azinobis-3-ethylbenzothiazoline-6-sulfonic acid) by reacting the $ABTS^{\cdot}$ radical with H_2O_2 in an acidic environment. The intensity of the color is lightened according to the amount of antioxidant capacity. The absorbance was measured spectrophotometrically at 660 nm. The results are presented as mmol Trolox Equiv./L [9].

2.2. Determination of Enzyme Inhibitory Effect

It was applied using the method, which is based on the α-amylase enzyme inhibition by acarbose. Enzyme solution was put to the extracts and placed in a microwell in phosphate buffer. After the mixture was left for pre-incubation, the reaction was initiated by adding starch solution. The same procedures were applied to the blank solution without enzyme. The reaction was terminated by adding HCl to the reaction. Absorbances were read at 660 nm by adding iodide-potassium iodide solution. % amylase inhibitions were calculated with the help of the following formula using the absorbance values read for all samples [10].

Inhibition (%) = [(A1- A2)/A1] x 100

A1: Absorbance of the control, which is considered 100% active, without added inhibitor (measured as a result of the enzymatic reaction without the use of extracts and standards)

A2: Absorbance of extracts containing inhibitors and solutions containing standard substances (measured absorbance as a result of enzymatic reaction when extract/standard is used)

α-glucosidase inhibitory activity (as in α-amylase) is based on its inhibition by acarbose. α-glucosidase solution was added to the extracts and placed in a microwell and the mixture was incubated. Another incubation was performed by adding 4-Nitrophenyl β-D-glucuronide (PNPG) solution to this mixture. Similar procedures were repeated for an enzyme-free blank sample. Absorbances were read at 400 nm. α-amylase and α-glucosidase inhibitory activities were presented as acarbose equivalent (mmol ACAE/g extract). % α-glucosidase inhibitions were calculated with the absorbance values read for all samples [10].

Acetylcholine esterase (AChE) inhibitory effect was done using the Ellman method. DTNB (5,5-dithio-bis-2-nitrobenzoic acid), acetylthiocholine iodide and AChE enzyme solution were used in the experimental stage. Absorbances were measured after incubation at 405 nm at 25 ºC. Anti-acetylcholine esterase activity was presented as mg GALAE (galantamine equivalent) /g extract. % acetylcholine esterase inhibitions were calculated with the absorbance values read for all samples [11].

L-DOPA (3,4-Dihydroxy-L-phenylalanine) substrate and tyrosinase enzyme are used to measure tyrosinase inhibition activity. The standard substance was prepared by dissolving kojic acid in the ethanol. Phosphate buffer, extract and enzyme solution were placed in the microwells. Substrate (L-DOPA) was added after incubation. Absorbance was measured at 492 nm. Anti-tyrosinase activity was presented as mg KAE (kojic acid equivalent)/g extract. % tyrosinase inhibitions were calculated using the absorbance values read for all samples [12].

2.3. Determination of Bioelement Concentrations and Essential Fatty Acid Content

Samples were taken from the plant to determine the bioelements contained in *P. afyonicum* and their concentrations. HNO_3 and H_2O_2 were burned on them in a microwave oven (Speed Wave, ERGHOF). The qualitative and quantitative analysis of the elements were determined by inductively coupled plasma-optical emission spectroscopy (ICP-OES, Spectro Genesis) [13].

The dried aerial parts of the plant were weighed (100 g), ground into powder in a mechanical grinder, and water distillation was applied for 4 hours using the Clevenger apparatus for the qualitative analysis of the essential fatty acid content of *P. afyonicum*. The percent yield values at the end of the distillation were calculated as 0.03%. Quantitative analysis of essential oil obtained by water distillation was determined by Spectrometer GC-MS (Gas Chromatography-Mass) techniques (Agilent, HP-Innowax FSC column (60m x 0.25mm x 0.25 µm film thickness). Identification of volatile components were evaluated according to standards and literature information. The percent areas of the peaks obtained from the flame ionization detector were used to determine the substance amounts. It was defined by the method of comparison with Wiley 9-nist 11 mass spectral database data.

2.4. Statistical Analysis

The data were defined as mean±standard deviation with the SPSS 18 statistical program. Normality testing was performed to determine statistical differences. Normally distributed data were analyzed with one-way analysis of variance (ANOVA) to determine statistical differences between groups ($p<0.05$). Duncan test was used to analyze differences between groups.

3. Results and Discussion

Studies to determine the plants biological activities and to obtain phytochemicals or new drug candidate molecules that provide this effect are quite common. Within the scope of exploratories of biological activities, studies against chronic diseases with high prevalence are the priority. It is important to find enzyme-inhibiting phytochemicals or agents for treatment, since it is usually enzymes, receptors and free radicals responsible for the pathology of these diseases for this reason [14]. Total antioxidant status, phenolic substance content, antiradicalic activity, enzyme inhibitory effects and content-based results (bioelement concentration and essential fatty acid) of *Polygonum afyonicum* methanol and acetone extracts were presented. Natural and synthetic antioxidants used as references.

3.1. Antiradicalic Activity

Reactive oxygen species react with cell membrane components to form a reaction cycle and damage the cell. The use of exogenous and endogenous antioxidants, it destroys the effects of reactive oxygen species and radicals. The suspicion that synthetic antioxidants cause adverse health effects increases the trend towards natural antioxidants. 2,2-diphenyl-1-picrylhydrazil, iron reducing effect, oxygen radical absorption capacity, 2,2-azino-bis 3-ethylbenzothiazoline-6-sulfonic acid, copper reducing activity, trolox equivalent antioxidant capacity are the most commonly used analytical tests. The 2,2-diphenyl-1-picrylhydrazil determination is an easy and fast way to measure antioxidants by spectrophotometer [15, 16].

The hydrogen atom donor ability of plant extracts and reference antioxidants was determined by decoloring the methanol solution of DPPH. DPPH is purple in methanol and turns purple in the presence of antioxidants, turning to yellow hues. The % inhibition of radical by extracts of *P. afyonicum* and standard substances are shown in Figure 1A and IC_{50} values are shown in Figure 1B. The results show that the acetone extract of the endemic species *P. afyonicum*

is a higher radical scavenger than the synthetic antioxidant BHT. The IC_{50} value of PAA is very close to the IC_{50} value of natural antioxidant.

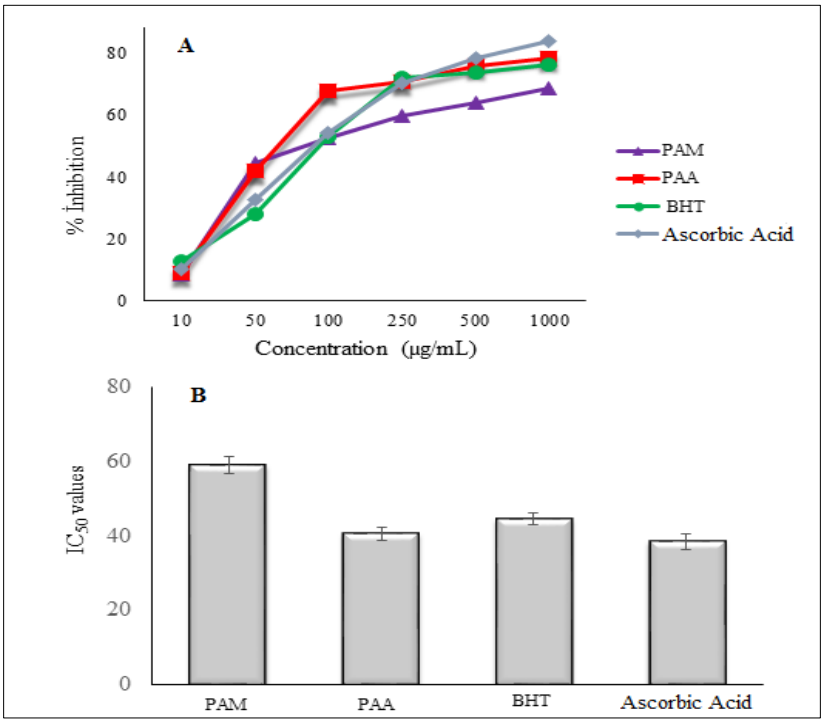

Figure 1 A; % inhibition of DPPH radical by methanol and acetone extracts of *Polygonum afyonicum* and standard substances and B; IC50 values of methanol and acetone extracts of *Polygonum afyonicum* and standard substances. PAM: *Polygonum afyonicum* methanol extract, PAA: *Polygonum afyonicum* acetone extract, BHT: Butylated hydroxy toluene

Similarly, 5,6-dihydropyranobenzopyronan isolated from *Polygonum amplexicaule* was found to be strong in scavenging oxygen-free free radicals in the literature [17]. MeOH extract of *Polygonum sachalinensis* has been reported to have antioxidant effects with radical scavenging features [18]. Also, *P. aviculare* L. extracts showed strong antioxidant effects with free radical and superoxide radical scavenging, lipid peroxidation, hydroxyl radical induced and DNA strand separation tests [19]. *Polygonum maritimum* extracts also showed a remarkable antioxidant scavenging effect on the DPPH radical [20].

3.2. Total Phenolic Content

Phenolic substances have an important role in protecting against the harmful effects of oxygen radicals and other reactive oxygen species. Most have essential, biologically active components (antiviral, anticarcinogenic, etc.) of plant-derived foodstuffs. Antioxidant activity plays a fundamental role in its pharmacological effects in many cases; therefore it can be considered the most important. The essential plant components of the food should be an adequate source of phenolic compounds for humans [2].

The Folin-Ciocalteu method is based on the fact that the phenolics in the extract transform the phosphowolframate-phospho molybdate complex into blue. In Figure 2, total phenolic content of *P. afyonicum* methanol and *P. afyonicum* acetone extracts and BHT are given. It was determined that the total phenolic content of PAA was statistically significantly higher than PAM ($p<0.05$). This value is also higher than BHT. Extracts containing high phenolic substances are also known to be a potent radical scavenger. Similarly, acetone extract with more phenolic content was found to be a stronger DPPH radical scavenger in this study.

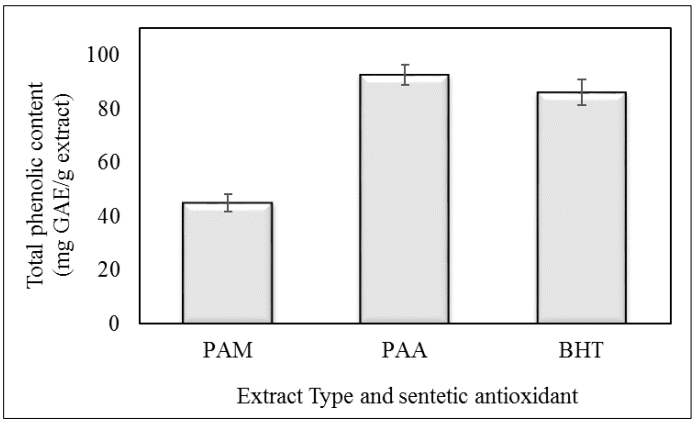

Figure 2 Total phenolic content of *Polygonum afyonicum* methanol and acetone extracts and standard. PAM: *Polygonum afyonicum* methanol extract, PAA: *Polygonum afyonicum* acetone extract, BHT: Butylated hydroxy toluene

It has been reported that phenolic substances such as, vanicode A, vanicode E and hydropiperoside B isolated from *Polygonum hydropiper* L. exhibit antioxidant activity. Flavonoids and flavonoid glucosides, especially galloyl quercitrin, show strong antioxidant effect [21, 22].

3.3. Total Antioxidant Status

The total antioxidant activity methods (such as TAS, FRAP and DPPH) of plant extracts, based on reaction with compounds/antioxidants that donate electrons or generate hydrogen radicals are used. It can be challenging to distinguish between electron and hydrogen atom transfer reactions. The datas are given in Figure 3. It was determined that the total antioxidant status of the acetone extract was statistically significant ($p<0.05$) higher than the methanol extract.

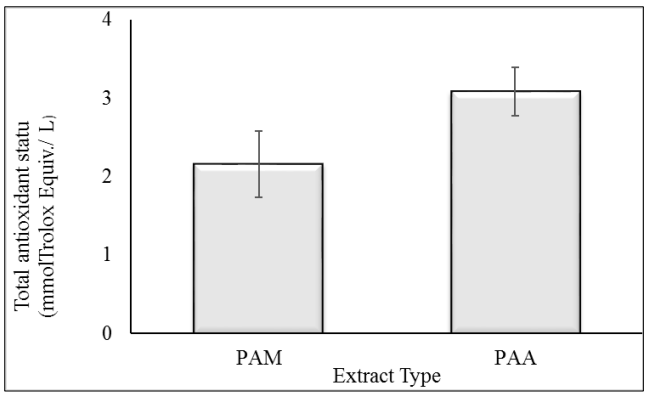

Figure 3 Total antioxidant status of methanol and acetone extracts of *Polygonum afyonicum* plant, PAM: *Polygonum afyonicum* methanol extract, PAA: *Polygonum afyonicum* acetone extract**.**

Isolates from *Polygonum multiflorum* showed strong antioxidant effects by increasing antioxidant enzymes glutathione peroxidase and superoxide dismutase activities in previous studies [23]. In addition, these isolates showed antioxidant activity by inhibiting the increase in MDA content [24]. It is stated that *Polygonum tinctorium* methanol and ethyl acetate extracts also exhibit high total antioxidant activity [25].

3.4. Enzyme Inhibitory Effect

Inhibition of the enzyme or enzymes responsible for the developing of any disease results in stopping this reaction and reducing/eliminating the undesirable discomfort. Enzyme inhibition-based protocols are frequently used in the treatment of diseases. Diabetes mellitus is a disease that develops when the pancreas cannot produce enough insulin or the insulin it produces cannot be used effectively. In treating of diabetes mellitus, insulin and its derivatives, sulfonylureas, incretins, α-amylase and α-glucosidase inhibitors, are the most commonly used antidiabetic agents [26, 27]. There are various side effects or disadvantages. Therefore, it is important to consider new therapeutic approaches [28]. Polysaccharides will be converted into monosaccharides by the α-amylase enzyme. More absorption and digestion

of monosaccharides, into the blood can be prevented with inhibiting the enzyme in diabetic patients [29]. Development of acarbose has opened a new avenue for treating diabetes. Acarbose delays carbohydrate digestion by inhibition of α-glucosidases, prolonging the total carbohydrate digestion time [30]. The inhibitory and % inhibition values of the enzymes involved in carbohydrate digestion of *Polygonum afyonicum* are given in Table 1. It is seen that the α-amylase inhibitory effect between PAM and PAA is not statistically different from each other ($p>0.05$). There was no statistical difference between these two extracts in % inhibitions on α-amylase. The % inhibitions of methanol extract and acetone extract on α-amylase were statistically different from the acarbose ($p<0.05$). The same is true for α-glucosidase. The only difference in the inhibitory property of α-glucosidase is that the acetone extract is partially more effective. However, the % inhibition of both extracts on α-glucosidase is not as effective as the standard substance acarbose. Therefore, it is thought that the methanol and acetone extracts of *P. afyonicum* cannot have an antidiabetic effect since they do not have significant inhibitory activities on α-amylase and α-glucosidase.

It has been shown that flavonones and anthraquinones obtained from leaf and flower extracts of *Polygonum sachalinensis* are antioxidant compounds. Phenylpropanoid glycosides obtained from *P. sachalinensis* rhizomes exhibit β-glucosidase inhibitory activity. Phytochemicals in this species are quercetin-3-O-β-D-galactopyranoside, quercetin-3-O-rabinopyranoside, hydropiperoside, vanicoside B, phenylacetonitrile, (E)-β-ocimene, linalool, α farnesene [31].

Alzheimer's is a progressive neurodegenerative disease. Current treatment for Alzheimer's consists of the administering of acetylcholine esterase [32]. AChE is an enzyme that hydrolyzes choline esters and is found in high concentrations in the brain, nerve and red blood cells. It has been observed that cholinergic neurons in the forebrain are highly damaged during the progression of Alzheimer's. Increasing the concentration of AChE in the synapse by inhibiting acetylcholine esterase is one of the approaches that slows the progression of Alzheimer's [33].

Polygonum afyonicum acetylcholine esterase inhibition is given in Table 1. The acetone extract of the species showed a higher effect in statistical significance ($p<0.05$) than the methanol extract. A similar situation is observed between % inhibitions. Even the % AChE inhibition of acetone extract is not statistically different from the galantamine. This indicates that the acetone extract of *P. afyonicum* is an agent that can be used for acetylcholine esterase inhibition.

Studies with *Polygonum multiflorum* show that it has lipid-lowering, antioxidant, antitumor, and treatment effect of intestinal, cardiovascular disorders, other neurological disorders often associated with aging. Many bioactive compounds in *P. multiflorum* are responsible for their medicinal activities. 2,3,5,4'-tetra hydroxy stilbene-2-O-beta-d-glucosidel, the main active stilbene glycoside, is antioxidant, has been reported to have anti-inflammatory, oncogenic enzyme inhibitory activities and endothelial protective [34].

Melanin is a pigment that plays roles in protecting against the sun’s harmful rays. It represents defense system of the skin against these factors. Different approaches to investigating skin disorders have been developed for conditions such as abnormal melanin pigmentation and melanoma. Tyrosinase is the enzyme in melanin biosynthesis. It is catalyzing the hydroxylation of L-tyrosine to DOPA (3,4-dihydroxyphenylalanine) and the oxidation of DOPA to dopaquinone. Melanin overproduction and accumulation occur in a various skin disorders. Since tyrosinase is the limiting step enzyme in melanogenesis, its inhibitors have become increasingly important as depigmenting agents in hyperpigmentation disorders [4, 35].

The anti-tyrosinase activity of plant extracts has been performed to find new sources of tyrosinase inhibitory compounds. There are many studies that show antityrosinase activity due to the phenols (hydroquinone, arbutin, resorcinol), polyphenols (sangenon, apigenin), flavanols (rutin, quercitin), anthocyanidin (malvidin, peonidin), coumarins, chalcones, phenolic acids and stilbenes that plants contain [4]. Anthraquinones extracted from *Polygonum cuspidatum* have been confirmed as anti-tyrosinase effects [36, 37].

Tyrosinase inhibition of *Polygonum afyonicum* is shown in Table 1. It is seen that the acetone extract of the *P. afyonicum* is more effective than the methanol extract ($p<0.05$). When the % antityrozinase effect is examined, it is seen that the % inhibition of the acetone extract of the species is higher than methanol but not as high as the standard substance kojic acid. It can be said that acetone extract is partially antityrosinase effective, although not as much as kojic acid.

Table 1 Inhibitory properties and % inhibition of methanol and acetone extracts on α-amylase, α-glucosidase, acetylcholine esterase, tyrosinase enzymes.

	PAM	**PAA**	**Standarts***
α-Amylase (mmol ACAE/g extract)	0.62±0.021[a]	0.64±0.015[a]	
% Inhibition	58.67±2.953[a]	60.62±3.05[a]	88.74±2.60[b]
α-Glucosidase(mmol ACAE/g extract)	0.76±0.021[a]	0.84±0.026[a]	
% Inhibition	55.18±2.2[a]	58.59±2.36[a]	90.07±3.33[b]
AChE (mg GALAE/g extract)	1.96±0.098[a]	2.98±0.083[b]	
% Inhibition	72.26±1.85[a]	86.97±3.76[b]	87.78±2.59[b]
Tyrosinase (mg KAE/g extract)	76.09±1.96[a]	106.17±2.45[b]	
% Inhibition	53.36±3.48[a]	72.62±2.66[b]	82.36±3.05[c]

Different superscripts on the same line indicate statistical difference ($p<0.05$). PAM; *Polygonum afyonicum* methanol extract, PAA; *Polygonum afyonicum* acetone extract, ACAE; Acarbose conjugate, GALAE; Galantamine conjugate, KAE; Kojic acid conjugate. *The standard substances are acarbose (for α-amylase and α-glucosidase enzymes); galantamine (for acetylcholine esterase enzyme); kojic acid (for tyrosinase enzyme)

3.5. Bioelement Concentration

Plants need elements to complete their normal growth and life cycles. Plants obtain essential elements from their roots or leaves. The soil where the plant grows must contain these nutrients. Plant uptake of the element depends on the chemical properties of the element and the pH of the soil, its interactions with soil colloids, and physical soil conditions such as temperature and humidity [38].

The biolements contained in *Polygonum afyonicum* and their concentrations were determined by ICP-OES and are given in Table 2. It was found that the *P. afyonicum* contains 16 elements. The macro elements with the highest concentration are Ca, K and Mg. In addition, elements that participate in the structure of antioxidant enzymes such as copper, iron, manganese and zinc are present in the structure of the species. The fact that it contains these elements supports for the species to come to the fore with its antioxidative properties. It is seen that the concentration of heavy metals such as Pb, which is one of the polluting environmental factors, is not high because it grows at a height and far from settlements and spreads in a narrow area as an endemic species.

Table 2 Bioelement Concentration of *Polygonum afyonicum*

Bioelement	**Concentration (ppm)**	**Bioelement**	**Concentration (ppm)**
Al	398.88±44.25	Cu	82.59±10.2
B	0.18±0.01	Fe	268.10±49.57
Ba	77.45±3.16	Mg	1804.19±371.62
Bi	9.39±0.38	Mn	30.87±1.71
Ca	5172.3±377.42	Na	164.18±44.61
Cr	1.25±0.08	Ni	2.07±0.69
Ga	0.22±0.02	Pb	0.99±0.02
K	4059.37±44.84	Zn	29.26±2.38

Results are given as mean ± standard deviation (mean±SD).

Similar to our study, the bioelement contents of nine *Polygonum multiflorum* samples were found to be in high concentrations of Ca, K, Mg. In addition, it was determined that aluminum, calcium, potassium, magnesium, strontium and titanium concentrations in wild *P. multiflorum* were significantly higher than those in cultured *P. multiflorum* [39].

3.6. Essential Fatty Acid Content

Essential oils are oxygenated mixtures of hydrocarbons and their isoprenoid derivatives. Essential oils are complex mixtures of hydrocarbons and aerobic hydrocarbons mainly composed of monoterpenes and sesquiterpenes. These oils are produced and secreted by glandular trichomes, specialized secretory tissues spread over the surface of plant organs, especially flowers and leaves [40].

Gas chromatography/Mass spectrometry was used to identify the components of the essential oil obtained from *P. afyonicum*. The essential fatty acid content of *P. afyonicum* more than 0.5% was determined qualitatively and quantitatively. The total essential oil content of the aerial parts of the *P. afyonicum* is 0.03%. It was determined 15 essential fatty acids and relative percent. Palmitic acid (42.5%), 1-octadecanol (9.2%), myristic acid (7.1%), hexahydrofarnesyl acetone (6.0%), pentacosane (3.8%) are the most abundant essential oils. Table 3 shows the essential fatty acids contained in *Polygonum afyonicum* and their relative percentages.

Table 3 Essential fatty acids and relative percentages of *Polygonum afyonicum*

Compound	Relative percent (%)
β-ionone	1.1
Heneicosane	2.1
Hexahydrofarnesyl acetone	6.0
Tricosane	2.6
1-Hexadecanol	1.3
Farnesyl acetone	0.7
Dodecanoic acid (Lauric acid)	0.8
Pentacosane	3.8
1-Octadecanol	9.2
Phytol	1.8
Tetradecanoic acid (Myristic acid)	7.1
1,21-Dokosadiene	0.8
Pentadecanoic acid	1.2
Nonacosane	2.5
Hexadecanoic acid (Palmitic acid)	42.5

The essential oils of *P. bistorta* L. rhizome collected from Shanghai, Guizhou, and Lahore (different regions of Asian) were extracted by hydrodistillation and analyzed by GC-MS in a study. The essential oil percentage yield was found to be between 0.11-0.29 %. A significant difference was found in their chemical composition. Furfural, oleic acid, oleic acid methyl ester, palmitic acid (5-methyl furfural, linoleic acid, linoleic acid methyl ester were major components [41]. In another study conducted with *Polygonum persicaria* L., it was stated that the total essential oil content was 1.10±0.09%, and the main components were 1,2-benzenedicarboxylic acid, hexadecanoic acid, hexacoson, oleic acid, trichosan, docosane.

4. Conclusion

This study examining some basic phytochemical properties of *Polygonum afyonicum*, an endemic species, shows that the extracts of the species, especially the acetone extract, are a better radical scavenger and more phenolic effective than the synthetic antioxidant BHT. The total antioxidant capacity of the acetone extract of the *P. afyonicum* is also high. It was also determined that *Polygonum afyonicum* extracts did not have an antidiabetic effect. The acetone extract of the plant stands out especially with its inhibitory effect on the acetylcholine esterase enzyme. It can be said that it is an effective neuroprotective species that can be used for the treatment of neurodegenerative diseases. At the same time,

this extract has a remarkable antityrosinase effect. These effects can be evaluated by performing tyrosinase inhibition and antiradical studies on the different solvents extracts of the plant. Structure elucidation studies are also needed to determine the components responsible for the neuroprotective effect of the species. Content analyzes such as polyphenolic substances and flavonoids in its structure should be carried out and metabolites that reveal these effects should be revealed. The study is important in terms of revealing the basic characteristics of the herb consumed by the local people in its green form and by making food, and to shed light on other studies to be done.

Compliance with ethical standards

Acknowledgment

This work is supported by the Scientific Research Project Fund of Afyon Kocatepe University (AKU-BAP) under the Project number 17.FEN.BİL.09 and 18.FEN.BİL.55

References

[1] Bourgaud F, Gravot A, Milesi S & Gonntier E, Production of plant secondary metabolites: a historical perspective. *Plant Sci*, 161 (2001) 839-851.

[2] Andlauer W, Stehle P & Furst P, Chemopreventions A novel approach in dietetics. C*urr Opin Clin Nutr Metab Care,* 1 (1998) 539-547.

[3] Yakoub AR, Abdehedic O, Jridi M, Elfalleh W, Nasri M & Ferchichi A, Flavonoids, phenols, antioxidant, and antimicrobial activities in various extracts from Tossa jute leave (*Corchorus olitorus* L.). *Ind Crops Prod*, 118 (2018) 206-213.

[4] Zolghadri S, Bahrami A, Khan MTH, Munoz-Munoz J, Garcia-Molina F, Garcia-Canovas F & Saboury AA, A comprehensive review on tyrosinase inhibitors. *J Enzyme Inhib Med Chem*, 34 (2019), 279-309.

[5] Keskin M, *Polygonum istanbulicum* Keskin sp. nov. (Polygonaceae) from Turkey. *Nord J Bot*, 27 (2009) 11-15.

[6] Aksoy L & Suyundikov M, Morphological and Phytochemical Properties of Endemic Plant Taxa in Afyonkarahisar Flora. *Turk J Biosci Collec*, 4 (2020) 20-26.

[7] Hazman Ö, Aksoy L, Büyükben A, Kara R, Kargıoğlu M, Kumral ZB & Erol İ Evaluation of antioxidant, cytotoxic, antibacterial effects and mineral levels of *Verbascum lasianthum* Boiss. ex Bentham. *An Acad Bras Ciênc*, 93 (2021), e20210865.

[8] Prior RL, Wu X & Schaich K, Standardized methods for the determination of antioxidant capacity and phenolics in foods and dietary supplements. *Food Chem*, 53 (2005) 4290-4302.

[9] Erel O, A new automated colorimetric method for measuring total oxidant status. *Clin Biochem*, 38 (2005) 1103-1111.

[10] Mahomoodally F, Sieniawska E, Sinan KI, Picot-Allain MCN, Yerlikaya S, Baloglu MC, Altunoglu YC, Senkardes I, Rengasamy KRr & Zengin G, Utilisation of *Rhododendron luteum* Sweet bioactive compounds as valuable source of enzymes inhibitors, antioxidant, and anticancer agents. *Food ChemToxicol*, 135 (2020) 111052.

[11] Ellman GL, Courtney KD, Andres VJr & Feather-Stone RM, A New and Rapid Colorimetric Essential Oil, Antioxidant, Antidiabetic, Anti-obesity, and Neuroprotective Properties of *Prangos Gaubae*. *Nat Prod Commun*, 12 (1961) 12.

[12] Sarikurkcu C, Kirkan B, Ozer MS, Ceylan O, Atilgan N, Cengiz M & Tepe B, Chemical characterization and biological activity of *Onosma gigantea* extracts. *Ind Crops Prod*, 115 (2018) 323-329.

[13] Karafakıoğlu YS, Aksoy L, Kargıoğlu M, Antioxidant Activity and Mineral Ingredient Assessment of Different Solvent Extracts of *Paronychia Chionaea*. *Pak J Bot*, 50 (2018) 1913-1916.

[14] Gholamhoseinian A & Zohre RZ, Screening the methanolic extracts of some plants for tyrosinase inhibitory activity. *Toxicol Environ Chem*, 94 (2012) 310-318.

[15] Kumar PS, Sucheta S, Deepa VS, Selvamani P & Latha S, Antioxidant activity in selected Indian medicinal plants. *Afr J Biotechnol*, 7 (2008) 1826-1828.

[16] Garcia EJ, Oldoni TLC, de Alencar SM, Reis A, Loguercio AD & Grande RHM, Antioxidant Activity by DPPH Assay of Potential Solutions to be Applied on Bleached Teeth. *Brazil Dent J*, 23 (2012), 22-27.

[17] Mudasir AT, Mohamed MR, Seema A & Ikhlas AK 5,6- Dihydropyranobenzopyrone: a previously undeterminedantioxidant isolated from *Polygonum amplexicaule*. *Chin J Nat Med*, 10 (2012) 28-31.

[18] Fan P, Terrier L, Hay AE, Marston A & Hostettmann K, Antioxidant and enzyme inhibition activities and chemical profiles of *Polygonum sachalinensis* F. Schmidt ex Maxim (Polygonaceae). *Fitoterapia*, 81 (2010) 124-131.

[19] Hsu CY, Antioxidant activity of extract from *Polygonum aviculare* L. *Biol Res*, 39 (2006).281-288.

[20] Imad AE, Fawzia AB, Wissame M, Faycal H & Mohamed AD, Screening of biological activities of *Polygonum maritimum* L. from Algerian coast. *Asian Pac J Trop Biomed*, 3 (2013) 611-616.

[21] Kiem PV, Nhiem NX, Cuong NX, Hoa TQ, Huong HT, Huong LM, Minh CV & Kim YH, New Phenylpropanoid Esters of Sucrose from *Polygonum hydropiper* and Their Antioxidant Activity. *Arch Pharm Res*, 31 (2008) 1477-1482.

[22] Zhao FP, Dieter S, Alfred B, Ramanathan S, Ngoh KG, Tet FC, Tan SN & Chia LS Antioxidant flavonoids from leaves of *Polygonum hydropiper* L. *Phytochemistry*, 62 (2003) 219-228.

[23] Chen Y, Wang MF, Robert TR & Ho CT, 2,2-Diphenyl-1- picrylhydrazyl Radical-Scavenging Active Components from *Polygonum multiflorum* Thunb. *J Agric Food Chem*, 47 (1999) 2226-2228.

[24] Liu LP, Liao ZP, Yin D, Li WD, Liu D, Li Q, Huang QR, Yang YF & He M The protective effects of *Polygonum multiflorum* stilbene glycoside preconditioning in an ischemia/reperfusion model of HUVECs. *Acta Pharmacol Sin*, 31 (2010) 405-412.

[25] Jang HG, Heo BG, Park YS, Namiesnik J, Barasch D, Katrich E, Vearasilp K, Trakhtenberg S & Gorinstein S, Chemical Composition, Antioxidant and Anticancer Effects of the Seeds and Leaves of Indigo (*Polygonum tinctorium* Ait.) Plant. *Appl Biochem Biotechnol*, 167 (2012) 1986-2004.

[26] Adeghate E, Medicinal chemistry of novel anti-diabetic drugs. *Open Medicinal Chemistry Journal,* 5 (2011) 68-69.

[27] Khatik GL, Datusalia AK, Ahsan W, Kaur P, Vyas M, Mittal A & Nayak SKA retrospect study on thiazole derivatives as the potential antidiabetic agents in drug discovery & developments. *Curr Drug Discov Technol*, 15 (2018) 163-177.

[28] Baynest HW, Classification, pathophysiology, diagnosis and management of diabetes mellitus. *J Diabetes Metab*, 6 (2015) 1-9.

[29] Wisessing A & Choowongkomon K, Amylase inhibitors in plants: structures, functions and applications. *Funct Plant Sci Biotechnol*, 6 (2011) 31-41.

[30] Bischoff H, The mechanism of alpha-glucosidase inhibition in the management of diabetes. *Clin Invest Med*, 18 (1995) 303-311.

[31] Kawai Y, Kumagai H, Kurihara H, Yamazaki K, Sawano R & Inoue N, Beta-glucosidase inhibitory activities of phenylpropanoid glycosides, vanicoside A and B from *Polygonum sachalinense* rhizome. *Fitoterapia*, 77 (2006) 456-459.

[32] Racchi M, Sironi M, Caprera A & Govoni S, Short- and long-term effect of acetylcholinesterase inhibition on the expression and metabolism of the amyloid precursor protein. *Mol Psychiatry*, 6 (2001) 520-528.

[33] Hasselmo ME, The role of acetylcholine in learning and memory. *Curr Opin Neurobiol*, 16 (2006) 710-715.

[34] Jang JY, Kim HN, Kim YR, Choi YW, Choi YH, Lee JH, Shin HK, Choi BT, Hexane extract from *Polygonum multiflorum* attenuates glutamate-induced apoptosis in primary cultured cortical neurons. *J Ethnopharmacol*,145 (2013) 261-268.

[35] Petrillo AD, González-Paramás AM, Era B, Medda R, Pintus F, Santos-Buelga C & Fais A, Tyrosinase inhibition and antioxidant properties of *Asphodelus microcarpus* extracts. *BMC Complement Altern Med*,16 (2016) 453.

[36] Leu YL, Hwang TL, Hu JW & Fang JY, Anthraquinones from *Polygonum cuspidatum* as tyrosinase inhibitors for dermal use. *Phytother Res*, 22 (2008), 552-556.

[37] Bao K, Dai Y, Zhu ZB, Tu FJ, Zhang WG & Yao XS, Design and synthesis of biphenyl derivatives as mushroom tyrosinase inhibitors. *Bioorg Med Chem*, 18 (2010) 6708-6714.

[38] Ajibola VO & Rolawanu R, Trace elements in the environment. *J Sci Ind Res*, 59 (2000) 132-136.

[39] Yan HJ & Fang ZJ, Study on determination and principal component analysis of inorganic elements in *Polygonum multiflorum* from different areas. *Zhongguo Zhong Yao Za Zhi*, 33 (2008) 416-419.

[40] Sharifi-Rad J, Sureda A, Tenore GC, Daglia M, Sharifi-Rad M, Valussi M, Tundis R, Sharifi-Rad M, Loizzo MR, Ademiluyi AO, Sharifi-Rad R, Ayatollahi SA & Iriti M Biological Activities of Essential Oils: From Plant Chemoecology to Traditional Healing Systems. *Molecules,* 22 (2017) 70.

[41] Intisar A, Zhang L, Luo H, Zhang R, Wu Z & Zhang W, Difference in Essential Oil Composition of Rhizome of *Polygonum bistorta* L. from Different Asian Regions and Evaluation of its Antibacterial Activity. *J Essent Oil Bear Plants*, 15 (2012) 964-971.