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# Research on selected wild edible vegetables: Mineral content and antimicrobial potentials

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**Abstract**

The present study was designed to examine the antimicrobial activity and to determine mineral contents of commonly consumed wild vegetables, which utilized mostly in southern parts of Turkey. Ten plantsbelonging to the different taxa (*Arum dioscoridis* Sm., *Chenopodium album* L., *Malva sylvestris* L., *Mentha longifolia* (L) Huds., *Nasturtium officinale* W.T. Aiton, *Papaver rhoeas* L., *Polygonum aviculare* L., *Rumex acetosella* L., *Sinapis alba* L. and *Urtica dioica* L.) were individually screened for their possible antibacterial and antifungal activities using both polar (methanolic) and nonpolar (n-hexane) crude extracts. Theextractswere tested against both standard American Type Culture Collection (ATCC) and Refik Saydam Turkish National Type Culture Collection (RSKK) and clinically isolated (CI) bacterial strains and two ATCC fungal strains.The efficacy of each plant extracts was tested by serial micro dilution method (MIC). Analyzed plant extracts demonstrated antimicrobial activity with the MIC values ranging 16 to 64 µg/ml against culture collection Gram negative bacteria and ≥ 256 µg/ml against isolated strains. The MIC values for selected extracts ranged from 16 to 256 µg/ml against culture collection Gram positive bacteria and ≥ 256 µg/ml against isolated strains. Among the plants tested, *C. album* (aqueous-methanolic) extracts demonstrated the highest antimicrobial activities againstall the test microorganisms with the best MIC (16 µg/ml) value. Furthermore, major and trace element concentrations were also screened and evaluated for their potential risk for public health by comparing with established limits proposed by various scientific reports.

**Key words:** Antibacterial, antifungal, extract, minimum inhibition concentration, mineral content, wild vegetable

## 1. Introduction

Medicinal and Aromatic Plants (MAPs) are of interest for human uses from the prehistoric times to the present. Importance and demand for medicinal and aromatic plants are associated with plant-based drugs, health products, pharmaceuticals, food additives, and cosmetics in addition to the economic value chain for developing countries (Iqbal, 2013; Pushpangadan, 2013;Yaldiz and Kulak, 2014; Scotti *et al.*, 2014; Udupa, 2016). Since the activity-induction of MAPs are directly associated with the standard content of potent metabolites, there is no homogeneity in these chemicals in MAPs, which results from noticeable impacts of climatic, ecological and other concerned phenomena. For this reason, there have been many attempts to determine biological activities of plants collected throughout the world (Scotti *et al.*, 2014; Mohmod and Mohtar, 2014; Khan *et al.*, 2016; Di Venere *et al.*, 2016).Turkey is one of the most important suppliers for MAPs on the worldwide due to its geographical condition and unique climate which result rich plant diversity. A number of plant species have been collected from nature, used traditionally and traded in Turkey (Yaldiz *et al.*, 2014; Karahan *et al.*, 2014). Wild edible plants have been collected from nature and used abundantly all over the world, but the understanding of medicinal properties, safety and efficacy have been a great concern in the recent years (Sekeroglu and Koca, 2010).

The increase in prevalence of common antibiotic resistant pathogenic microorganisms in the last years requires new alternative antimicrobial agents. Natural herbal products offer new antimicrobial agents and a huge number of novel drug components have been isolated from plants (Nascimento *et al.*, 2000; Obeidat *et al.*, 2012). The wild collected and consumed plants by people have lesser side effects once compared to synthetic or semi-synthetic drug agents. A huge number of preliminary studies have been performed in order to determine the potent antimicrobial agents (Obeidat *et al.*, 2012; Molla *et al.*, 2010; Kang *et al.*, 2011).

In addition to the secondary metabolite content and composition in commonly consumed plants, their mineral composition also has a vital importance for proper human health through modulation of enzymes and thus in an essential way affecting the biochemical and

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physiological processes in cellular metabolism (Lozak *et al.*, 2002). From the view of recent scientific reports, desired quantity of mineral composition and contents in food and medicinal plants are advised for healthy life. However; it is furthermore emphasized that excessive doses and accumulation of these elements, especially heavy metals, could cause serious health problems.To determine the mineral compositions of some food and medicinal crops, scientific studieshave recently been enhanced. Most of the Turkish medicinal plants and products have also been studied for their mineral compositions, as well. In the recent years, we have focused on the determination of mineral contents of edible parts of the plants (Sekeroglu and Koca, 2010; Ozkutlu *et al.*, 2007; Sekeroglu *et al.*, 2008; Koca *et al.*, 2009; Ozkutlu *et al.*, 2011; Sekeroglu *et al.*, 2011; Tuncturk *et al.*, 2011; Sekeroglu *et al.*, 2012).

Our goal is to evaluate the antimicrobial efficacy of ten selected wild vegetables, (*A. dioscorides*, *C. album*, *M. sylvestris*, *M. longifolia*, *N. officinale*, *P. rhoeas*, *P. aviculare*, *R. acetosella*, *S. alba*, and *U. dioica*) utilized by the local people of mostly southeastern part of Turkey, against Gram-positive, Gram-negative bacteria and fungi, which were regarded as human pathogenic microorganisms. Furthermore, since they were wild grown in uncontrolled soil conditions, mineral content analysis of edible parts of these plants were screened and the concentrations of trace elements were compared with the critical levels established or proposed for safe consumption.

## 2. Materials and Methods

### 2.1 Plant material

The herbal sample consisted of ten different Turkish dietary plants namely (*A. dioscorides*, *C. album*, *M. sylvestris*, *M. longifolia*, *N. officinale*, *P. rhoeas*, *P. aviculare*, *R. acetosella*, *S. alba*, and *U. dioica*) were wild collected during their vegetation periods and further botanically identified at the Department of Biology, Faculty of Arts and Sciences, Kilis 7 Aralýk University (Kilis, Turkey), where the voucher specimens were deposited with reference numbers.Collected plants were cleaned, dried at room temperature and then powdered for the subsequent extraction process.

### 2.2 Preparation of plant extract

A polar and a nonpolar extract were prepared from each samples, the extraction process included two steps as follows:

**Step 1 (nonpolar extract):** Powdered plant parts (30 g) were macerated with *n*-hexane (300 ml) by leaving them overnight incubation on a rotary shaker. After filtration, once more extraction was performed on the residue. Then filtrated extracts were combined and concentrated *in vacuo* at 40ºC using a Rotary evaporator (Buchi, Germany). Then the extracts were kept in the dark at +4ºC until tested. The residue kept for the further methanol extraction.

**Step 2 (polar extract):** Residue obtained from hexane extraction was macerated with 70% methanol (300 ml) by leaving them overnight for incubation on a rotary shaker. After extract filtration, once more extraction was performed on the residue. Then filtrated extracts were combined and concentrated in vacuo at 40ºC using a Rotary evaporator (Buchi, Germany). Then the extracts were kept in the dark at +4ºC until tested.

### 2.3 Preparation of test and standard samples

Test samples were dissolved at concentration of 512 mg/ml in solvent (Tween 80: Me-OH; 80%) and this concentration was used as a stock solution. Reference antibiotics Ampicillin (AMP), Levofloxacin (LVX), Gentamicin (GM) and Trimethoprim-sulfamethoxazole (TMP-SMX) were purchased from Sigma-Aldrich Co. Ketoconazole (KET) and Fluconazole (FLU) used as reference antimycotic drugs. Reference standards were dissolved and solubilized in phosphate buffer (ampicillin, ph 8.0, 0.1 mol/l), distilled water (levofloxacin, gentamicin, trimethoprim-sulfamethoxazole, fluconazole) and dimethylsulfoxide (ketoconazole) and tested as control group. Stock solutions were prepared according to the Clinical Laboratory Standard Institute (CLSI) (CLSI, formerly NCCLS, 2008).

### 2.4 Microorganisms

Both standard American Type Culture Collection (ATCC) and Refik SaydamTurkish National Type Culture Collection (RSKK) and clinically isolated (CI) bacterial strains were procured from Pharmaceutical Microbiology Division, Pharmacy Faculty, Gazi University (Ankara, Turkey).Standard and clinical isolated strains of *Pseudomonas aeroginosa* (ATCC 10145/isolated strain), *Acinetobacer baumannii* (RSKK 02026/ isolated strain), *Salmonella enteriditis* (RSKK 538/ isolated strain), *Staphylococcus aureus* (ATCC 25923/ isolated strain), *Enterococcus faecalis* (ATCC 29212/ isolated strain), and *Bacillus subtilis* (ATCC 6633 / isolated strain) were used for antibacterial assays. *Candida albicans* ATCC 10231 and *Candida krusei* ATCC 6258 were used for antifungal assays.

### 2.5 Inoculation of test organisms

Bacterial strains were maintained on Mueller-Hinton Broth (MHB, Difco) and in Mueller-Hinton Agar (MHA; Oxoid). Culture suspensions were prepared at concentration of $10^5$cfu/ml bacteria from bacterial culture suspension containing a concentration of bacteria that approximates the McFarland 0,5 ($10^8$cfu/ml). Sabouraud liquid medium (SLM; Oxoid) and Sabouraud dextrose agar (SDA; Oxoid) was used in the preparation of antifungal culture suspension. The test suspension of fungi culture in RPMI-1640 (L-glutamine, pH 7, 3- [N-morpholino]-propansulfonic) was spectrophotometrically prepared at $2.5x10^3$cfu/ml concentration (Kästner *et al*., 1998).

### 2.6 Minimum inhibitory concentration (MIC)

The MIC value of the extracts was regarded as the lowest concentration that completely inhibited bacterial growth after 18-24 h of incubation at 37ºC. The efficacy of each plant extract was tested by serial micro dilution method. 2-fold serial dilutions (256 to 0.125 µg/ml) of extracts were carried out to determine the MIC using a ninety-six well microliter plate method. 10 µl of bacterial/ fungal suspension were added to each well and MIC values were determined after 18-24 h. post-incubation at 37ºC.

### 2.7 Preparation of plant samples for mineral content analyzes

First of all, the plant samples were cleaned and washed by deionized water and air dried. Pre-dried samples were de-moisturized at 70ºC for 48 h in an oven and ground for chemical analysis. 0.2 g of ground samples were placed into burning cup, 5 mL $HNO_3$ 65% (Merck, Darmastadt, Germany) and 2 mL $H_2O_2$ 30%, (Merck, Darmastadt, Germany) were added immediately. After incinerating in a HP-500 CEM MARS 5 microwave (crop. Mathews NC, USA) at 200ºC, the solution was cooled at room temperature for 45 min. The extracts were passed through a Wattman 42 filter paper and the filtrates were collected by high-deionized water in a 20 mL of polyethylene bottles and kept at 4ºC in laboratory for Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) analysis. Each sample was analyzed in triplicate.

For all analytical works, distilled-deionized water was used. All the glassware and polyethylene bottles were attentively leached with 2-4% HCl and rinsed through deionized water for three times. Merck standards (R1 and R2 groups) were used as analytical reagent grade chemicals. Standard solutions of Cd, Cu, Fe, Mn and Zn were prepared in 1% $HNO_3$ immediately before the analysis by serial dilution of 1000 mg/l stock solution stored in polyethylene bottles. Corn Bran (standard reference material, 8433) and Peach leaves (standard reference material, 1547) were used as reference materials (NIST, 2004).

### 2.8 Instrumentation and analytical procedures

The ICP-OES (Varian Vista-Pro, Australia) was used to determine the minerals. The wavelengths of the method were Al (396,152), B (208,889), Ca (370,602), Cd (214,439), Co (230,786), Cr (205,560), Cu (324,754), Fe (238,204), K (404,721), Mg (383,829), Mn (257,610), Mo (203,846), Na (588,995), Ni (216,555), P (213,618), Pb (220,353), S (181,972) and Zn (213,857) in the extracts.

## 3. Results and Discussion

Possible antibacterial and antifungal activities of methanol and n-hexane extractsfrom ten wild edible plants including *Arum dioscoridis* Sm., *Chenopodium album* L., *Malva sylvestris* L., *Mentha longifolia* (L) Huds., *Nasturtium officinale* W.T. Aiton, *Papaver rhoeas* L., *Polygonum aviculare* L., *Rumex acetosella* L., *Sinapis alba* L. and *Urtica dioica* L. were analyzed in the present work. Additionally mineral compositions of the used plant parts were also determined. All the results obtained from laboratory analysis were given in details under subtitles and compared with former scientific references here.

### 3.1 Antimicrobial activity

Antimicrobial activity of the extracts of ten wild edible plants was screened. Methanol-aqueous and *n*-hexane extracts of the plants were tested against certain Gram-positive and Gram-negative bacteriaand fungi, which were regarded as human pathogenic microorganisms. The efficacy of each plant extract was tested by serial micro dilution method (MIC) and was compared with standard antibiotics.Culture collection strains and recently isolated strains were used. MIC is defined as the highest dilution or the least concentration of the extracts that cease growth of microorganism. Extracts of selected plants demonstrated activity with the MIC values ranging 16 to 64 µg/ml against culture collection Gram negative bacteria and ≥ 256 µg/ml against isolated strains. The MIC values for selected extracts ranged from 16 to 256 µg/ml against culture collection Gram positive bacteria and ≥ 256 µg/ml against isolated strains. Among the plants tested, *Chenopodium album* (aqueous-methanolic) extracts showed the highest activity against all the test microorganisms with the best MIC (16 µg/ml) value. Antibacterial activities of n-hexane extracts were more effective than the aqueous-methanolic extracts. Isolated strains were more resistant to the all plant extracts tested in this work (with MIC ≥ 256 µg/ml).It is reported that the crude extract of a plant can only be considered promising when MIC< 100 g/ml is achieved (Rios and Recio, 2005). Each plant extract obtained from different organic solvents could be considered to possess promising inhibitory effect against microorganisms tested in the present study.

**Table 1:** MIC values of the plant extracts against gram negative bacteria (µg/ml)

| Extracts | Gram negative bacteria | | | | | |
|---|---|---|---|---|---|---|
| | *P. aeruginosa* | | *A. baumannii* | | *S. enterititis* | |
| | ATCC 1045 | Isolated strains | RSKK 02026 | Isolated strains | RSKK 538 | Isolated strains |
| *A. dioscorides* MeOH | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| *C. album*, MeOH-Water | 16 | ≥256 | 64 | ≥256 | 16 | ≥256 |
| *M. sylvestris*, MeOH-Water | 64 | ≥256 | 64 | ≥256 | 256 | ≥256 |
| *M. longifolia*, MeOH-Water | 64 | ≥256 | 64 | ≥256 | 128 | ≥256 |
| *N. officinale*, MeOH-Water | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| *P. rhoeas*, MeOH-Water | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| *P. aviculare*, MeOH-Water | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| *R. acetosella*, MeOH-Water | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| *S. alba*, MeOH-Water | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| *U. dioica*, MeOH-Water | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| *A. dioscorides*, Hexane | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| *C. album*, Hexane | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| *M. sylvestris*, Hexane | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| *M. longifolia*, Hexane | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| *N. officinale*, Hexane | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| *P. rhoeas*, Hexane | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| *P. aviculare*, Hexane | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| *R. acetosella*, Hexane | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| *S. alba*, Hexane | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| *U. dioica*, Hexane | 64 | ≥256 | 64 | ≥256 | 64 | ≥256 |
| AMP | - | - | 2 | ≥128 | - | - |
| LFX | 1 | 64 | 0.12 | 64 | 0.12 | 64 |
| GM | 0.5 | 2 | - | - | - | - |
| TMP-SMX | - | - | - | - | 1 | - |

AMP:Ampicillin; LFX: Levofloxacin; GM: Gentamicin; TMP-SMX:Trimetoprim-sulfametoxazol

**Table 2:** MIC values of the plant extracts against gram positive bacteria (µg/ml)

| Extracts | Gram positive bacteria | | | | | |
|---|---|---|---|---|---|---|
| | *S. aureus* | | *E. faecalis* | | *B. subtilis* | |
| | ATCC 25923 | Isolated strains | ATCC 29212 | Isolated strains | ATCC 6633 | Isolated strains |
| *A.dioscorides*MeOH | 256 | ≥256 | 256 | ≥256 | 128 | ≥256 |
| *C.album*, MeOH-Water | 16 | ≥256 | 16 | ≥256 | 16 | ≥256 |
| *M.sylvestris*, MeOH-Water | 256 | ≥256 | 256 | ≥256 | 128 | ≥256 |
| *M.longifolia*, MeOH-Water | 128 | ≥256 | 128 | ≥256 | 64 | ≥256 |
| *N.officinale*, MeOH-Water | 64 | ≥256 | 64 | ≥256 | 32 | ≥256 |
| *P.rhoeas*, MeOH-Water | 128 | ≥256 | 128 | ≥256 | 64 | ≥256 |
| *P.aviculare*, MeOH-Water | 64 | ≥256 | 64 | ≥256 | 32 | ≥256 |
| *R.acetosella*, MeOH-Water | 64 | ≥256 | 64 | ≥256 | 32 | ≥256 |
| *S.alba*, MeOH-Water | 64 | ≥256 | 64 | ≥256 | 32 | ≥256 |
| *U.dioica*, MeOH-Water | 64 | ≥256 | 64 | ≥256 | 32 | ≥256 |
| *A.dioscorides*, Hexane | 64 | ≥256 | 64 | ≥256 | 32 | ≥256 |
| *C.album*, Hexane | 64 | ≥256 | 64 | ≥256 | 32 | ≥256 |
| *M.sylvestris*, Hexane | 256 | ≥256 | 256 | ≥256 | 128 | ≥256 |
| *M.longifolia*, Hexane | 64 | ≥256 | 64 | ≥256 | 32 | ≥256 |
| *N.officinale*, Hexane | 64 | ≥256 | 64 | ≥256 | 32 | ≥256 |
| *P.rhoeas*, Hexane | 64 | ≥256 | 64 | ≥256 | 32 | ≥256 |
| *P.aviculare*, Hexane | 64 | ≥256 | 64 | ≥256 | 32 | ≥256 |
| *R.acetosella*, Hexane | 64 | ≥256 | 64 | ≥256 | 32 | ≥256 |
| *S.alba*, Hexane | 64 | ≥256 | 64 | ≥256 | 32 | ≥256 |
| *U.dioica*, Hexane | 64 | ≥256 | 64 | ≥256 | 32 | ≥256 |
| AMP | <0.12 | >128 | 0.5 | >128 | 0.12 | 0.5 |
| LVX | 0.25 | 128 | 0.5 | 32 | - | - |

AMP:Ampicillin; LFX: Levofloxacin

**Table 3:** MIC values of the plant extracts against fungal strains (µg/ml)

| Extracts | *C. albicans* | *C. krusei* | Extracts | *C. albicans* | *C. krusei* |
|---|---|---|---|---|---|
| | ATCC 10231 | ATCC 6258 | | ATCC 10231 | ATCC 6258 |
| *A.dioscorides* MeOH | 16 | 32 | *C. album*, Hexane | 16 | 64 |
| *C.album*, MeOH-Water | 16 | 32 | *M.sylvestris*, Hexane | 16 | 32 |
| *M.sylvestris*, MeOH-Water | 16 | 32 | *M.longifolia*, Hexane | 16 | 64 |
| *M.longifolia*, MeOH-Water | 32 | 64 | *N.officinale*, Hexane | 16 | 64 |
| *N.officinale*, MeOH-Water | 16 | 32 | *P.rhoeas*, Hexane | 16 | 64 |
| *P. rhoeas*, MeOH-Water | 16 | 32 | *P.aviculare*, Hexane | 16 | 64 |
| *P.aviculare*, MeOH-Water | 16 | 32 | *R.acetosella*, Hexane | 16 | 64 |
| *R.acetosella*, MeOH-Water | 16 | 32 | *S.alba*, Hexane | 16 | 64 |
| *S.alba*, MeOH-Water | 16 | 32 | *U.dioica*, Hexane | 16 | 64 |
| *U.dioica*, MeOH-Water | 16 | 32 | KET | 0.5 | 1 |
| *A.dioscorides*, Hexane | 32 | 64 | FLU | 2 | 4 |

Ketoconazole KET: Ketoconazole; FLU: Fluconazole

Ampicillin (AMP), Levofloxacin (LFX), Gentamicin (GM) and Trimetoprim-sulfametoxazol (TMP-SMX) used as reference antibiotics showed variable inhibitory activity on different bacterial strains with MIC values ranging from 0.12 to 128 µg/ml, but AMP did not exhibit antibacterial activity against *Pseudomonas aeroginosa* (ATCC 10145/isolated strain) and *Salmonella enteriditis* (RSKK 538/isolated strain). GM did not show any inhibitory effect on *Acinetobacterbaumannii* (RSKK 02026/ isolated strain) and*S. enteriditis* (RSKK 538/isolated strain). TMP-SMX almost had no activity on gram-negative bacteria except MIC value 1 µg/ml against RSKK 02026 *A.baumannii*. LFX also did not inhibit *Bacillus subtilis* (ATCC 6633/ isolated strain) growth. However, the present results indicate that antibacterial efficacy of extracts change depending on plant species, solvent and tested microorganism. We should note that in general, all the tested microorganisms were inhibited at the various levels of MIC by each extracts of different organic solvents.

Extracts of selected plants exhibited inhibitory activity with the MIC values ranging 16 to 64 µg/ml against *C. albicans* ATCC 10231 and *C. krusei* ATCC 6258 but extracts were more active against *C. krusei* ATCC 6258. Ketoconazole (KET) and Fluconazole (FLU) used as reference antimycotic drugs showed antifungal activities at variable degrees with MIC values from 0.5 to 4 µg/ml.

### 3.2 Mineral content of edible parts

The concentration of 19 elements in edible parts of plants were collectively represented in Tables 4 and 5. It was determined that each plant contains significant values of elements, of whichcontent in each plant presented a wide variability. Macro and microelements determined in varying concentrations (mg/kg level based on dry weight) were Al, Ar, B, Ca, Cd, Co, Cr, Cu,Fe, K, Mg, Mn, Mo, N, Na, Ni, P, Pb, S and Zn.

#### Aluminum (Al)

The content of Al, which is known as one ofthe toxic elements, ranged from 161 (*U. dioica*) to 548 mg/kg (*P. rhoeas*). The critical Al level for most food plants is at 7-104 mg/kg (Kabata-Pendias and Mukherjee, 2007). The concentration of Al is much more than the critical levels proposed.

#### Argon (Ar)

The concentration of Arin the various plants was found to vary from 87.6 (*S. alba)*to 92.3 mg/kg (*P. rhoeas*) mg/kg.

#### Boron (B)

The concentration of B varied between 20.9 and 26.9 mg/kg but all values were closer to each other except *U. dioica* (26.9 mg/kg). Contents of B in plants vary in the range of 5-30 mg/kg (Kabata-Pendias and Pendias, 2001). The concentration of B is also in good agreement with the report by Koca *et al.,* (2008).

#### Cadmium (Cd)

Cd is not required for metabolic processes, but its relatively easy bioavability to plants reveals serious health risk for the subsequent consumption. Therefore, the determination of Cd in plants is a great concern. The content of Cd ranging from 0.0 to 0.82 mg/kg was lower-except *N. officinale* (0.82 mg/kg) than the limit of 0.3 mg/kg, which was considered as the upper limit recommended for medicinal plants for safe human consumption (WHO, 1999). There are also limits proposed as sufficient or normal (0.01-0.2 mg/kg), excessive or toxic (5-30 mg/kg), and tolerable in crop plants (0.05-0.5 mg/kg) (Kabata-Pendias and Mukherjee, 2007). Cd concentration in the samples are within the tolerable ranges.

#### Cobalt (Co)

Cobalt is essential to both plants and humans (He *et al*., 2005) but there are no established criteria for cobalt in medicinal plants (Ashraf *et al*., 2010). Theconcentration for Co was determined to be between 0,15mg/kg (*A. dioscorides*) and 1,63 mg/kg (*P. rhoeas*) in this study.The results coincided with previous studies (Koca *et al.,* 2008; Aziz *et al.,* 2007).

#### Chromium (Cr)

Chromium is considered as an essential micronutrient in human metabolic processes but excessive concentration has been associated with carcinogens. Therefore, the proper balance of dietary Cr is critical (Avci, 2012).Contents of Cr either varies from 0.01 to 0.35 mg/kg (Kabata-Pendias and Pendias, 2001), or from 0.07 to 0.41 mg/kg (Bratakos *et al.,* 2002), or the permissible levels (0.02 mg/kg), which has been established as the upper limit for safe human consumption recommended for medicinal plants (FAO/WHO, 1984) but the concentration of Cr varied in the range of 0.65 (*U. dioica*) and 9.08 (*P. rhoeas*) mg/kg. According the limits described by Kabata-Pendias and Mukherjee (2007), the excessive or toxic concentration for Cr is between 5 and 30 mg/kg. Hence, the all measured concentration is over the acceptable range for human consumption.

#### Copper (Cu)

Cu content, in general, vary from .8 to 6.7 mg/kg for wheat grains, 3-8 mg/kg for leafy vegetables (Kabata-Pendias and Mukherjee, 2007) and 3.0 mg/kg for edible plants (FAO/WHO, 1984). Sufficient and tolerable limits were described to be within the ranges of 5 to 30 mg/kg and 5 to 20 mg/kg (Kabata-Pendias and Mukherjee, 2007). The Cu content ranged from 6.5 (*S. alba*) to 18.4 mg/kg (*C. album*) in our study. Thus, the measured concentration is in the acceptable range but we should note that accumulation of trace elements can bring about challenges for proper health.

#### Iron (Fe)

Iron is an essential nutrient for all organisms and required for the hemoglobin formation and transfer of oxygen and electron (Kaya and Incekara, 2000)and the amount of Fe in various cereal grains do not differ much. The mean content ranges between 31 to 98 mg/kg (Kabata-Pendias and Mukherjee, 2007) and 20 mg/kg for edible plants (FAO/WHO, 1984). Fe content varied between 234 mg/kg (*U. dioica*) and 975 mg/kg (*P. rhoeas*) in the present study. Fe contents of the herbs were reported to be in the range of 224-502.7 mg/kg according to the report by Basgel and Erdemoglu (2006).

#### Manganese (Mn)

Contents of Mn in plants widely vary depending on the plant species and their organs. The manganese limit set for edible plant was 2 mg/kg (FAO/WHO, 1984). It was found to vary between 35 mg/kg (*P. aviculare* and *A. dioscorides*) and 116 mg/kg (*R. acetosella*) in the present study.In some previous literatures, the detected levels of Mn were in the ranges of 21.40 -77. 40 mg/kg (33), 0.36-1,64 mg/kg (Erdogrul *et al*., 2005) and 23. 0-244 mg/kg (Basgel and Erdemoglu, 2006). The present results coincided with the previous reports but still over than the limit proposed by (FAO/WHO, 1984).

**Molybdenum (Mo)**

Various food plants do not differ much in the concentration of Mo and the concentration is regarded to be about 0.5 mg/kg (Kabata-Pendias and Mukherjee, 2007). In the present study, Mo content ranged from 0.26 (*U. dioica*) to 4.77 mg/kg (*S. alba*).The amount of Mo in certain South African medicinal plants was reported to range from 0.080 to 0.364 mg/kg (Street *et al*., 2008). In the present study, the measured contents were higher except *U. dioica* - than the limit described by Kabata-Pendias and Mukherjee (2007).

**Nickel (Ni)**

Sufficient or normal and tolerable concentrations (mg/kg) of Ni were proposed to range within 0.1-5 and 1-10 mg/kg but 10-100 mg/kg concentration is regarded as excessive or toxic (Kabata-Pendias and Mukherjee, 2007). Ni concentration was found to range from 1.5 (*U. dioica*) to 23.7 mg/kg (*P. rhoeas*). The Ni concentration of *P. rhoeas* and *S. alba* are within the range of toxicity.

**Lead (Pb)**

The permissible level established in edible plants for Pb is 0.43 mg/kg (FAO/WHO, 1984) but the concentration ranged between 0.04 (*M. sylvestris* and *S. alba* ) and 1.40 mg/kg (*P. aviculare*) in the present study. The plants -except *A. dioscorides* and *P. aviculare* - may be regarded to be within the safe limit for Pb.

**Zinc (Zn)**

The content of Zn ranged from 10.0 and 97.0 mg/kg with the highest value in *N. officinale* and lowest level in *M. sylvestris*. 74,3 mg/kg (Isýloglu *et al*., 2001) but Basgel and Erdemoglu (2006) reported the content to be 0.26 to 4.80 mg/kg. The WHO limits for this metal has not yet been published.

**Table 4:** Micro elements composition of selected edible plants

| Plant species | Mineral composition (mg/kg) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Al** | **B** | **Ca** | **Cd** | **Co** | **Cr** | **Cu** | Fe |
| ***A.dioscorides*** | 263 ± 5 | 21,4 ± 0,8 | 10990 ± 15 | 0,04 ± 0,00 | **0,15** ± 0,01 | 1,67 ± 0,04 | 7,7 ± 1,1 | 358 ± 11 |
| ***C.album*** | 208 ± 11 | 25,0 ± 1,4 | 12829 ± 241 | 0,27 ± 0,03 | 0,33 ± 0,02 | 1,16 ± 0,05 | **18,4** ± 0,6 | 305 ± 9 |
| ***M.sylvestris*** | 181 ± 9 | 24,2 ± 3,2 | 13787 ± 301 | 0,03 ± 0,00 | 0,31 ± 0,03 | 2,15 ± 0,07 | 10,3 ± 0,9 | 334 ± 2 |
| ***M.longifolia*** | 250 ± 9 | **20,9** ± 1,5 | 15044 ± 645 | 0,02 ± 0,00 | 0,29 ± 0,05 | 0,90 ± 0,09 | 12,6 ± 0,8 | 313 ± 3 |
| ***N.officinale*** | 379 ± 29 | 26,9 ± 1,6 | 28532 ± 662 | **0,82** ± 0,07 | 1,10 ± 0,04 | 1,18 ± 0,03 | 15,3 ± 0,4 | 389 ± 15 |
| ***P.rhoeas*** | **548** ± 66 | 22,8 ± 1,7 | 12355 ± 205 | 0,04 ± 0,00 | **1,63** ± 0,11 | **9,08** ± 0,39 | 11,5 ± 0,7 | **975** ± 36 |
| ***P.aviculare*** | 494 ± 8 | 25,3 ± 1,0 | 14690 ± 438 | 0,28 ± 0,04 | 0,22 ± 0,02 | 1,56 ± 0,09 | 7,7 ± 0,4 | 570 ± 43 |
| ***R.acetosella*** | 429 ± 63 | 23,5 ± 2,1 | **7659** ± 482 | 0,03 ± 0,01 | 0,49 ± 0,05 | 2,14 ± 0,19 | 9,5 ± 0,7 | 630 ± 1 |
| ***S.alba*** | 252 ± 5 | 22,7 ± 1,0 | 24702 ± 422 | 0,40 ± 0,07 | 0,38 ± 0,05 | 2,29 ± 0,02 | **6,5** ± 0,7 | 407 ± 6 |
| ***U. dioica*** | **161** ± 2 | **55,9** ± 1,2 | **77752** ± 4593 | **0,00** ± 0,00 | 0,16 ± 0,01 | **0,65** ± 0,07 | 10,7 ± 0,4 | **234** ± 2 |
| Corn bran (NIST-RM 8433) | 1,01 | 2,8 | 420 | 0,012 | 0,006 | 0,11 | 2,47 | 1,48 |
| Peach leaves (NIST-RM 1547) | 249 | 29 | 1,56 | 0,026 | 0,07 | 1 | 3,7 | 218 |

*Bold numbers indicate the lowest and highest mean values per mineral

**Table 5:** Macro elements composition of selected edible plants

| Plant species | Mineral composition (mg/kg) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **K** | **Mg** | **Mn** | **Mo** | **Na** | **Ni** | **P** | **Pb** | **S** | **Zn** |
| ***A.dioscorides*** | 37774 ± 2508 | **2457** ± 61 | **35** ± 3 | 0,69 ± 0.13 | **491** ± 15 | 2,8 ± 0.1 | 4213 ± 159 | 0,54 ± 0.61 | **3937** ± 89 | 27,3 ± 3,2 |
| ***C.album*** | 30233 ± 1085 | 3962 ± 53 | 53 ± 4 | 0,79 ± 0.06 | **6332** ± 427 | 6,4 ± 0.4 | 4193 ± 132 | 0,07 ± 0.01 | 7050 ± 637 | 39,5 ± 2,1 |
| ***M.sylvestris*** | 30712 ± 407 | 7615 ±545 | 43 ± 3 | 1,33 ± 0.18 | 495 ± 21 | 4,1 ± 0.7 | 6151 ± 213 | **0,04** ± 0.01 | 5461 ± 56 | **10,0** ± 1,5 |
| ***M.longifolia*** | 25994 ± 9 | 6368 ±186 | 66 ± 7 | 1,09 ± 0.11 | 594 ± 62 | 2,1 ± 0.1 | **3492** ± 130 | 0,05 ± 0.01 | 4796 ± 147 | 47,5 ± 5,0 |
| ***N.officinale*** | **24578** ± 596 | 5230 ±382 | 109 ± 11 | 0,90 ± 0.04 | 4325 ± 318 | 6,5 ± 0.7 | 4155 ± 219 | 0,07 ± 0.02 | **10801** ± 1416 | **97,0** ± 17 |
| ***P.rhoeas*** | 47518 ± 681 | 6936 ± 90 | 46 ± 3 | 2,08 ± 0.13 | 918 ± 96 | **23,7** ± 3.9 | **6913** ±1291 | 0,10 ± 0.00 | 4636 ± 50 | 33,6 ± 0,9 |
| ***P.aviculare*** | **55791** ± 295 | 2943 ± 81 | **35** ± 4 | 0,49 ± 0.05 | 1261 ± 86 | 2,5 ± 0.2 | 4490 ± 269 | **1,40** ± 0.28 | 5059 ± 623 | 19,4 ± 0,5 |
| ***R.acetosella*** | 27537 ± 655 | 3726 ±104 | **116** ± 7 | 1,12 ± 0.01 | 3086 ± 161 | 6,0 ± 0.2 | 5795 ± 417 | 0,24 ± 0.08 | 5109 ± 129 | 58,4 ± 4,8 |
| ***S.alba*** | 34561 ± 621 | **8643** ±504 | 43 ± 3 | **4,77** ± 1.09 | 486 ± 8 | 10,1 ± 0,4 | 6303 ± 570 | **0,04** ± 0.00 | 8380 ± 28 | 26,2 ± 1,8 |
| ***U. dioica*** | 41077 ± 1306 | 7663 ±194 | 64 ± 8 | **0,26** ± 0.09 | 538 ± 53 | **1,5** ± 0.1 | 3574 ± 317 | 0,05 ± 0.01 | 4631 ± 326 | 27,6 ± 3,7 |
| Corn bran (NIST-RM 8433) | 566 | 818 | 2,55 | 0,252 | 430 | 0,158 | 171 | 0,140 | 860 | 18,6 |
| Peach leaves (NIST-RM 1547) | 2,43 | 0,432 | 98 | 0,060 | 24 | 0,69 | 0,137 | 0,87 | 0,2 | 17,9 |

*Bold numbers indicate the lowest and highest mean values per mineral

Concerning the macro elements, the arrays of calcium (Ca), magnesium (Mg), potassium (K), phosphorus (P), Sulphur (S), sodium (Na) and nitrogen (N) were also determined in the selected plants. The concentration 7659 (*R. acetosella*) to 77752 mg/kg (*U. dioica*) for Ca, 2457 (*A. dioscoridis*) to 8643 (*S. alba*) mg/kg for Mg, 24578 (*N. officinale*) to 55791mg/kg (*P. aviculare*) for K, 491 (*A. dioscoridis*) to 6332 mg/kg (*C. album*) for Na, 3937 (*A. dioscoridis*) to 10801 mg/kg (*N. officinale*) for S, 3492 (*M. longifolia*) to 6913 mg/kg (*P. rhoeas*) for P, 3937 (*A. dioscoridis*) to10801 (*N. officinale*) for S were measured for the plants.Ca and K concentrations were in the ranges proposed in previous reports (Lokhande *et al.*, 2009; Imelouane *et al.*, 2011; Gupta *et al.*, 2014). Mg concentration coincided with the previous reports (Holland *et al.*, 1997; Corlett *et al.*, 2002; Turan *et al.*, 2003). P concentration was in agreement with the reports by (Koca *et al.*, 2008; Ozcan and Akbulut, 2008). S and Na concentrations were higher than the previous reports (CLSI, 2008; Koca *et al.*, 2008; Ozkutlu *et al.*, 2011).

## 4. Conclusion

The resultsdemonstrated that the selected wild edible plants/ vegetables have promising antimicrobial activities against certain microorganisms but some edible plant parts accumulated higher concentration of trace elements more than critical levels. That might because of the collection site. The extracts having high level of trace elements were collected close to road site or industrial part of the cities. If enough attention cannot pay to the collection site of the plants, safety problems in consumption come up for local inhabitants. In this context, further studies concerned with environmental monitoring and assessment for regions subjected or polluted with heavy metals in widely consumed crops should be carried out.

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### Conflict of interest

We declare that we have no conflict of interest.

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