ICP-OES analysis of heavy metal and nutrient elements of yarrow sold in Turkey

Ümmüşen Gökçen[a], Yavuz B. Köse[b], Hassan Y. Aboul-Enein[c], Göksel Arli[b]

[a]Department of Biology, Faculty of Science and Art, Osmangazi University, [b]Department of Pharmaceutical Botany, Faculty of Pharmacy, Anadolu University, Eskisehir, Turkey, [c]Department of Pharmaceutical and Medicinal Chemistry, Pharmaceutical and Drug Industries Research Division, National Research Center, Cairo, Egypt

Correspondence to Hassan Y. Aboul-Enein, PhD, DSc, Department of Pharmaceutical and Medicinal Chemistry, Pharmaceutical and Drug Industries Research Division, National Research Center, Dokki, Cairo 12622, Egypt Tel: +20 100 367 8948; fax:+20 3337 0931; e-mail: haboulenein@yahoo.com

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Aim
The present study was to evaluate the local 'yarrow' drug – Millefoli herba – samples acquired from aktars, herbalists, and herbal shops.
Materials and methods
The samples were from Ankara (10 samples), Antalya (14 samples), Eskisehir (11 samples), Istanbul (10 samples), Izmir (10 samples), Mersin (10 samples), and Ordu (seven samples), which are used in the traditional medicine for various purposes. More than 70 samples were evaluated from seven different provinces.
Results
The taxonomic diagnosis of some of them is sold as *Achillea millefolium* L.; however, the study results show that the drugs do not belong to this species, and also five different *A.* L. taxa are sold as *A. millefolium* L. The selected heavy metals (Fe, Cd, and Co) and plant nutritional elements (Mn, Zn, Na, K, Ca, B, and Mg) were initially determined by quantitative ICP-OES analyses. Among the investigated samples, the lowest and highest results were 0.365–18.86 mg/kg for Fe; 0.007–0.294 mg/kg for Cd; 0.022–0.027 mg/kg for Co; 0.097 mg/kg–2.098 mg/kg for Mn; Zn 0.009–0.624 mg/kg; Na 1.539–15.80 mg/kg; K 39.8–390.3 mg/kg; Ca 31.24–223.1 mg/kg; B 0.046–3.970 mg/kg; Mg 7.058–43.84 mg/kg, respectively.
Conclusion
The results were compared with WHO recommended limits and daily intakes.

Keywords:
Achillea L, heavy metal, ICP-OES, nutrients, yarrow

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Introduction

The use of medicinal plants for the purpose of treatment has begun with the history of humanity. The oldest recordings in respect of the use of herbs in the cure of illnesses have based on the written sources left from China, India, and North Africa civilizations [1–4].

WHO announced that in the world, approximately four billion people try to remove their health problems with herbal drugs in the first phase. WHO stated that in the world, the number of used herbs are about 20 000 and 4000 of these herbs that are widely used as drugs [5].

In Turkey, the number of medicinal herbs are not rigorously known, but it is estimated that ~500 herbs are used for the purpose of curing ailments. The export potential of 200 medicinal and aromatic herbs has been indicated [6,7].

In the studies evaluating medicinal herbs in terms of heavy-metal contents, as well as Cu, Co, Zn, Mn, and Fe, which are found naturally in herbs and are necessary for human health; however, Ni, Pb, Cd, As, and Hg show toxic effects when they reach certain limit values [8].

Heavy metals accumulated in the structure of plants hinder the physical activity, decrease the yields, and even can cause plants' death. Therefore, heavy metals affect adversely every step of agriculture and cause production and quality to decrease. These elements are transmitted to the soil with the precipitations and flow to the rivers by percolating. The use of rivers with the aim of watering, accumulation in the soil because of the overuse, and transmission of these metals to the living creatures affect adversely their lives [9,10].

The most of health problems, requiring diagnosis and treatment to the highest degree, caused by metals and especially the heavy metals, are chronic diseases or cancers. In many of them, treatment possibilities are quite restricted and sequentially or frequently death can be observed. This situation makes us think that primary

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safeguard measures will be able to be more successful than secondary and tertiary-treatment services. At first, safekeeping the essential purpose is to prevent the contact with the active ingredient risky for lives of living beings. Earth's crust confronts us as the most important pollution source for these substances. At this point, the collaboration of different disciplines is thought to provide significant contributions for the prevention of contact of toxic metals with people [11–13].

Achillea L. (Asteraceae) species, commonly known as 'yarrow,' have been used in folk medicine for numerous medicinal properties. The name of *A.* originated from the name of 'Achilles' from Greek mythology, as he used yarrow to treat his bleeding ankle and wounds. Today, several therapeutic applications, such as anti-inflammatory, wound healing, and spasmolytic and choleretic uses, are approved by scientific experimental results [14,15].

The aim of this study was to determine heavy metals and other nutritional elements in the samples sold as yarrow from the different cities of Turkey by ICP-OES.

Materials and methods

Plant samples

Achillea species, drugs sold with the name of 'yarrow,' were supplied from Ankara (10 samples), Antalya (14 samples), Eskisehir (11 samples), Istanbul (10 samples), Izmir (10 samples), Mersin (10 samples), and Ordu (seven samples). In the study, 72 herbalist samples were used as materials (Table 1). Identification of

Table 1 Samples and herbalists

	Species	City
1	*Achillea falcata* L	Ankara
2	*Achillea falcata* L	Ankara
3	*Achillea millefolium* L	Ankara
4	*Achillea biebersteinii* Afan	Ankara
5	*Achillea millefolium* L	Ankara
6	*Achillea falcata* L	Ankara
7	*Achillea falcata* L	Ankara
8	*Achillea falcata* L., *Achillea millefolium* L. mixture	Ankara
9	*Achillea falcata* L	Ankara
10	*Achillea falcata* L	Ankara
11	*Achillea phrygia* Boiss. et Bal	Antalya
12	*Achillea biebersteinii* Afan	Antalya
13	*Achillea wilhelmsii* C. Koch	Antalya
14	*Achillea biebersteinii* Afan	Antalya
15	*Achillea biebersteinii* Afan	Antalya
16	*Achillea biebersteinii* Afan	Antalya
17	*Achillea falcata* L	Antalya
18	*Achillea phrygia* Boiss. et Bal	Antalya
19	*Achillea falcata* L	Antalya
20	*Achillea biebersteinii* Afan	Antalya
21	*Achillea falcata* L	Antalya
22	*Achillea falcata* L	Antalya
23	*Achillea wilhelmsii* C. Koch	Antalya
24	*Achillea wilhelmsii* C. Koch	Antalya
25	*Achillea falcata* L	Eskisehir
26	*Achillea millefolium* L	Eskisehir
27	*Achillea millefolium* L	Eskisehir
28	*Achillea kotschyi* Boiss	Eskisehir
29	*Achillea phrygia* Boiss. et Bal., *Achillea biebersteinii* Afan. mixture	Eskisehir
30	*Achillea wilhelmsii* C. Koch	Eskisehir
31	*Achillea millefolium* L	Eskisehir
32	*Achillea millefolium* L	Eskisehir
33	*Achillea millefolium* L	Eskisehir
34	*Achillea falcata* L	Eskisehir
35	*Achillea falcata* L	Eskisehir
36	*Achillea millefolium* L	Istanbul
37	*Achillea millefolium* L	Istanbul

(*Continued*)

Table 1 (*Continued*)

	Species	City
38	*Achillea millefolium* L	Istanbul
39	*Achillea falcata* L., *Achillea biebersteinii* Afan. mixture	Istanbul
40	*Achillea falcata* L	Istanbul
41	*Achillea millefolium* L., *Achillea falcata* L. mixture	Istanbul
42	*Achillea millefolium* L.	Istanbul
43	*Achillea millefolium* L., *Achillea biebersteinii* Afan., *Achillea falcata* L. mixture	Istanbul
44	*Achillea falcata* L	Istanbul
45	*Achillea millefolium* L	Istanbul
46	*Achillea phrygia* Boiss. et Bal	Izmir
47	*Achillea millefolium* L	Izmir
48	*Achillea biebersteinii* Afan	Izmir
49	*Achillea millefolium* L	Izmir
50	*Achillea millefolium* L	Izmir
51	*Achillea millefolium* L	Izmir
52	*Achillea millefolium* L	Izmir
53	*Achillea millefolium* L	Izmir
54	*Achillea millefolium* L	Izmir
55	*Achillea millefolium* L	Izmir
56	*Achillea falcata* L	Mersin
57	*Achillea falcata* L	Mersin
58	*Achillea falcata* L	Mersin
59	*Achillea falcata* L	Mersin
60	*Achillea falcata* L	Mersin
61	*Achillea falcata* L	Mersin
62	*Achillea falcata* L	Mersin
63	*Achillea falcata* L	Mersin
64	*Achillea falcata* L	Mersin
65	*Achillea falcata* L	Mersin
66	*Achillea falcata* L	Ordu
67	*Achillea falcata* L	Ordu
68	*Achillea falcata* L	Ordu
69	*Achillea falcata* L	Ordu
70	*Achillea falcata* L	Ordu
71	*Achillea falcata* L	Ordu
72	*Achillea falcata* L	Ordu

imported commercially available samples was done by using Flora of Turkey.

Analytical procedure

With the aim of measuring the amount of heavy metals, glass, plastic, and porcelain materials used stayed in detergent water. After that, they were washed with running water and transferred to 20% HNO_3 solution. Also, to clean the waste whose dissolution is too hard in the glass materials, chromic acid solvent was used. Plant samples brought to the laboratory, after being washed by distilled water, were dried at 105°C and were homogenized. Dried plant samples were weighed at a precision balance as 0.3 g and transferred into pots whose volume capacities are 60 mm, and which can resist to maximum 40-bar pressure and 230°C. In high heat-resistant and pressure-tight pots, six samples can be passed into solution at the same time. After addition of 10 ml of HNO_3 and 10 ml of H_2O_2, in the process of making samples soluble, Berghof speedwave MWS-3+ model microwave bakery was used. The procedure of heavy- metal specification was done at the Perkin Elmer Optical Emission Spectrometer Optima 4300 Dv device.

Statistical analysis

SPSS statistical programme was used for statistical analysis (Table 2). Average, SD, minimum, and maximum values, which were read for three times, have been calculated. Besides 'Statistical Package for the Social Sciences' (SPSS 10.0) (IBM SPSS, Armonk, NY, USA) programme was used to provide easiness in the evaluation of gained data (Table 2).

Results and discussion

According to botanical identification of plant samples, it was determined that six different species were sold as yarrow. These species are *Achillea biebersteinii* Afan., *Achillea falcata* L., *Achillea phrygia* Boiss. et Bal., *Achillea kotschyi* Boiss., *Achillea wilhelmsii* C. Koch., and *Achillea millefolium* L. (Table 1).

The content of sodium found in plants changes between 0.01 and 10%. In a study on the different parts of medicinal plants, sodium concentrations were examined and it was determined that sodium concentrations were among 31.90–860.20 mg/kg in consequence of this study [16,17]. Sodium surplus causes high blood pressure, potassium loss, overhydration, and edema. Sodium creates adverse impacts such as forgetfulness and hypotension in the case of its lack. Daily sodium need should be 5–15 mg for a person. According to our measurements, in plant samples, the least sodium-amount accumulation is 10 539 mg/kg and the highest sodium-amount accumulation is 15.80 mg/kg (Table 3).

In the lack of potassium, carbohydrate metabolism breaks down. Circumstantially when weak scape and stem are seen, resistance to illnesses decreases [18–21]. WHO emphasizes that daily potassium need should be at least 3510 mg for a person to protect against diseases and to balance the blood pressure [22]. According to our measurements, in plant samples, the least potassium-amount accumulation is 39.8 mg/kg and the highest potassium-amount accumulation is 390.3 mg/kg (Table 3).

While calcium lack is causing chlorosis in young leaves, in the excessive lack of calcium, necrosis can also be seen in leaves [23–25]. In the plant of *Gentiana olivieri*, the minimum ratio of calcium was found as 3358 mg/kg and the maximum ratio was 17 642 mg/kg in the plant's roots [16]. In the different parts of *Arnebia densiflora*, calcium concentration was investigated and that the content of calcium changes between 9203 and 37 637 mg/kg was seen [17]. According to our measurements, in plant samples, the least calcium-amount accumulation is 31.24 mg/kg and the highest calcium-amount accumulation is 223.1 mg/kg (Table 3).

In people, magnesium lack stimulates osteolysis, nervous system, and heart diseases, and thus the magnesium quantity asked to be consumed reaches 300–420 mg [26]. The content of magnesium was determined between 117.1 and 1141.6 mg/kg in some spices and medicinal herbs [27]. According to our measurements, in plant samples, the least magnesium-amount accumulation is 7.058 mg/kg and the highest magnesium-amount accumulation is 43.84 mg/kg (Table 3).

Whereas Turkish food codex allows 52 mg/kg iron in nourishment, WHO/FAO reports that this limit reaches up to 200 mg/kg. Lack of iron causes anemia, nosebleed, etc., in people and the toxic limit of iron is defined as 200 mg/kg for people and 10 200 mg/kg for plants [27,28]. The trace iron amount plants can have in their structure is 20–200 mg/kg [29]. According to our measurements, in plant samples, the least iron-amount accumulation is 0.365 mg/kg and the highest iron-amount accumulation is 18.86 mg/kg (Table 3).

In plants, more than 260-ppm boron-element concentration is evaluated as toxic [30]. The trace boron amount plants can have in their structure is

Table 2 Statistics findings

Species	Na	K	Ca	Mg	Fe	B	Zn	Mn
Achillea falcata								
Average	0.05379	1.17200	0.89850	0.21435	0.01115	0.119.3	0.00143	0.00224
N	34	34	34	34	34	28	30	33
Std. deflection	0.020268	0.527928	0.401957	0.055271	0.018420	0.360479	0.000774	0.001393
Std. error average	0.003476	0.090539	0.068935	0.009479	0.003159	0.068124	0.000141	0.000242
Minimum	0.034	0.429	0.260	0.069	0.003	0.001	0.001	0.001
Maximum	0.131	3.252	1.845	0.305	0.114	1.563	0.004	0.006
Achillea millefolium								
Average	0.08523	1.57064	0.84932	0.16932	0.02282	0.00330	0.07750	0.00523
N	22	22	22	22	22	20	22	22
Std. deflection	0.135153	0.591111	0.342947	0.035159	0.032132	0.001559	0.349885	0.002959
Std. error average	0.028815	0.126025	0.073117	0.007496	0.006850	0.000349	0.074596	0.000631
Minimum	0.015	0.331	0.348	0.110	0.003	0.001	0.001	0.002
Maximum	0.680	2.641	1.855	0.249	0.157	0.007	1.644	0.014
Achillea biebersteinii								
Average	0.03271	1.56771	0.53383	0.14050	0.85700	0.00480	0.01450	0.00633
N	7	7	6	6	6	5	6	6
Std. deflection	0.016948	1.008944	0.147101	0.082170	2.051250	0.002588	0.030165	0.006377
Std. error average	0.006406	0.381345	0.060054	0.033546	0.837419	0.001158	0.012315	0.002603
Minimum	0.012	0.001	0.349	0.058	0.008	0.002	0.001	0.001
Maximum	0.058	2.733	0.708	0.262	5.044	0.007	0.076	0.017
Achillea phrygia								
Average	0.05550	1.46425	0.94850	0.20700	0.03050	0.01567	0.34000	0.00450
N	4	4	4	4	4	3	4	4
Std. deflection	0.019416	0.723162	0.641987	0.123199	0.025723	0.015011	0.677333	0.003873
Std. error average	0.009708	0.361581	0.320994	0.061600	0.012861	0.008667	0.338667	0.001936
Minimum	0.033	0.546	0.387	0.080	0.011	0.007	0.001	0.001
Maximum	0.077	2.305	1.859	0.365	0.067	0.033	1.356	0.010
Achillea wilhelmsii								
Average	0.06225	1.72175	0.94275	0.17500	0.02225	0.00750	0.00125	0.00225
N	4	4	4	4	4	4	4	4
Std. deflection	0.040582	0.266122	0.369443	0.073910	0.007411	0.009110	0.000500	0.000500
Std. error average	0.020291	0.133061	0.184722	0.036955	0.003705	0.004555	0.000250	0.000250
Minimum	0.026	1.496	0.494	0.068	0.016	0.002	0.001	0.002
Maximum	0.120	2.077	1.385	0.238	0.032	0.021	0.002	0.003
Achillea kotschyi								
Average	0.03400	1.21400	0.68300	0.23200	0.01000	0.00200	0.00100	0.00500
N	1	1	1	1	1	1	1	1
Std. deflection								
Std. error average								
Minimum	0.034	1.214	0.683	0.232	0.010	0.002	0.001	0.005
Maximum	0.034	1.214	0.683	0.232	0.010	0.002	0.001	0.005
Total								
Average	0.06164	1.37964	0.85472	0.19177	0.08794	0.05759	0.04778	0.00370
N	72	72	71	71	71	61	67	70
Std. deflection	0.077464	0.621951	0.384244	0.062143	0.597043	0.248584	0.258042	0.003118
Std. error average	0.009129	0.073298	0.045601	0.007375	0.070856	0.031828	0.031525	0.000373
Minimum	0.012	0.001	0.260	0.058	0.003	0.001	0.001	0.001
Maximum	0.680	3.252	1.859	0.365	5.044	1.563	1.644	0.017

3.0–90 mg/kg [29]. The toxic effects of boron are seen, such as headache, vomiting, diarrhea, exaltation, or depression in adults and coma in children. The pink color seen on fingertips are characteristic indications of boron intoxication [31]. According to our measurements, in plant samples, the least boron-amount accumulation is 0.046 mg/kg and the highest boron-amount accumulation is 3.970 mg/kg (Table 3).

The trace zinc amount plants can have in their structure is 20–100 mg/kg [29]. The zinc amount plants take is stated in a source as 3.6–5.5 mg/kg. In Turkish food,

Table 3 Heavy metal contents and plant nutrients

	Na	K	Ca	Mg	Fe	B	Zn	Cd	Co	Mn
1	6.7	119.6	124	34.63	1.39	0.227	0.338	<D.L.	<D.L.	0.244
2	6.377	105.1	85.88	23.33	0.873	0.117	0.205	<D.L.	<D.L.	0.209
3	4.656	239	100.9	17.78	1.841	0.352	0.362	0.008	<D.L.	0.611
4	5.345	328	72.57	23.95	1.003	0.332	0.624	0.021	<D.L.	1.382
5	10.91	317	149.2	29.97	5.830	0.171	0.81	<D.L.	<D.L.	0.831
6	5.239	105	77.42	23.82	0.930	0.173	0.208	<D.L.	<D.L.	0.213
7	6.137	122.9	75.59	22.38	0.810	0.070	0.202	0.01	<D.L.	0.239
8	4.126	189.6	96.40	20.61	13.79	0.186	0.219	0.009	<D.L.	0.606
9	5.007	78.23	58.91	17.71	0.757	<D.L.	0.129	<D.L.	<D.L.	0.143
10	6.610	115.6	136.5	32.37	1.090	0.226	0.318	<D.L.	<D.L.	0.305
11	9.330	191.1	223.1	43.84	3.696	0.957	0.166	<D.L.	<D.L.	0.592
12	6.985	316.3	84.96	20.22	2.341	0.939	0.252	<D.L.	<D.L.	0.353
13	5.627	249.3	166.3	23.63	1.962	2.525	0.211	<D.L.	<D.L.	0.358
14	2.305	75.62	41.97	7.058	0.988	0.853	0.181	<D.L.	<D.L.	0.162
15	1.539	124	<D.L.	<D.L.	<D.L.	<D.L.	<D.L.	0.027	<D.L.	<D.L.
16	4.904	233.1	79.20	31.44	5.524	0.776	0.315	<D.L.	<D.L.	0.701
17	7.783	390.3	186.6	36.60	2.252	0.965	0.356	<D.L.	<D.L.	0.715
18	5.693	276.7	77.97	17.75	1.788	3.970	0.163	0.015	<D.L.	0.228
19	4.388	51.53	31.24	8.393	0.406	1.004	0.101	<D.L.	<D.L.	0.097
20	2.120	212.8	59.34	8.193	2.139	0.310	0.224	<D.L.	<D.L.	0.298
21	4.531	73.12	53.08	14.66	0.702	1.607	0.146	<D.L.	<D.L.	0.161
22	4.752	74.31	55.98	13.96	0.547	1.502	0.125	0.011	0.027	0.166
23	10.47	212.8	77.83	22.12	1.074	0.343	0.168	0.057	<D.L.	0.243
24	6.906	179.6	104.1	23.79	3.858	0.329	0.257	<D.L.	<D.L.	0.326
25	6.101	107.8	69.91	24.52	0.831	0.088	0.270	0.015	<D.L.	0.179
26	5.482	171.5	82.85	24.61	1.732	0.391	0.364	<D.L.	<D.L.	0.469
27	7.789	169.9	64.22	17.46	1.912	0.343	0.298	0.012	<D.L.	0.594
28	4.132	145.7	82.06	27.86	00.18	0.262	0.213	0.007	0.022	0.631
29	7.816	169.7	107.9	28.35	0.008	0.892	0.280	<D.L.	<D.L.	1.252
30	14.46	185	123	28.67	2.950	0.666	0.182	<D.L.	<D.L.	0.371
31	4.895	188.4	107.7	15.81	3.459	0.500	0.342	<D.L.	<D.L.	0.568
32	3.868	126.2	105.9	20.45	1.157	0.743	0.507	<D.L.	<D.L.	0.615
33	4.864	222.4	222.6	33.72	2.591	0.507	0.503	<D.L.	<D.L.	0.402
34	6.716	116.1	118.7	30.33	0.831	0.226	0.286	<D.L.	<D.L.	0.421
35	6.793	107.6	86.11	31.45	1.321	0.046	0.208	<D.L.	<D.L.	0.187
36	6.434	235.6	107.2	19.92	1.290	0.350	0.483	0.012	<D.L.	0.484
37	10.51	128.2	95.33	23.65	1.109	0.521	0.288	<D.L	<D.L.	0.732
38	11.90	168	85.17	22.73	1.190	0.682	0.275	<D.L.	<D.L.	0.484
39	5.993	140.3	94.01	22.12	1.406	0.255	0.207	<D.L.	<D.L.	0.287
40	6.263	124.7	100.3	27.82	1.026	0.187	0.234	0.015	<D.L.	0.286
41	6.596	136.1	86.65	24.27	1.410	0.361	0.267	<D.L.	<D.L.	0.470
42	7.210	143.1	79.54	20.19	4.399	0.556	0.364	< D.L.	<D.L.	1.083
43	9.573	165.8	106.7	22.73	1.190	0.682	0.275	<D.L.	<D.L.	0.484
44	6.194	84.85	88.05	20.88	1.083	0.095	0.205	<D.L.	<D.L.	0.235
45	5.294	172.3	80.36	18.64	0.365	0.562	0.241	<D.L.	<D.L.	0.533
46	3.977	65.61	46.45	9.696	1.428	<D.L.	0.162	<D.L.	<D.L.	0.430
47	7.464	272.2	86.97	22.46	3.714	0.359	0.419	<D.L.	<D.L.	1.174
48	4.763	151.2	46.64	10.57	0.605	<D.L.	0.009	<D.L.	<D.L.	2.098
49	8.240	215.9	182.4	22.65	2.606	0.279	0.372	<D.L.	<D.L.	0.494
50	6.368	259.4	136.6	19.44	0.895	0.580	0.379	0.007	<D.L.	0.443
51	3.428	281.7	86.68	17.19	0.873	0.232	0.239	<D.L.	<D.L.	0.336
52	10.35	290.4	93.30	19.99	0.924	0.465	0.611	0.294	<D.L.	0.387
53	12.82	39.8	98.40	25.15	3.722	0.956	0.443	0.008	<D.L.	1.233
54	3.712	91.01	41.81	13.35	0.888	<D.L.	0.197	<D.L.	<D.L.	0.321
55	5.191	113.7	42.81	14.56	1.131	0.072	0.288	<D.L.	<D.L.	0.474
56	15.80	208.1	108.3	30.92	0.496	0.347	0.359	0.017	<D.L.	0.233
57	4.225	187.5	103.3	28.66	1.364	0.370	0.176	<D.L.	<D.L.	0.512

(*Continued*)

Table3 (*Continued*)

	Na	K	Ca	Mg	Fe	B	Zn	Cd	Co	Mn
58	4.362	149.9	80.90	23.68	0.675	0.186	0.190	<D.L.	<<D.L.	0.310
59	8.537	180.8	221.5	30.34	1.111	0.582	0.129	<D.L.	<D.L.	0.520
60	4.132	145.7	82.06	27.86	18.86	0.262	0.213	0.007	0.022	0.631
61	5.602	130.2	68.44	27.62	0.960	0.085	0.199	<D.L.	<D.L.	0.245
62	4.194	39	204.2	25.11	1.149	0.361	0.128	<D.L.	<D.L.	0.458
63	6.542	142.4	181.8	33.25	1.719	0.441	0.113	<D.L.	<D.L.	0.492
64	13.56	210.2	146.6	33.84	0.981	0.512	0.453	0.016	<D.L.	0.755
65	5.660	144.1	199	32.12	1.378	0.566	0.468	<D.L.	<D.L.	0.469
66	6.463	122	71.11	22.19	0.899	0.222	0.314	0.009	<D.L.	0.175
67	9.892	149.7	162.9	35.81	0.7	0.795	0.139	<D.L.	<D.L.	0.402
68	5.741	136.1	80.68	25.63	1.014	0.120	0.251	0.014	<D.L.	0.347
69	5.556	90.73	74.15	19.30	0.831	0.257	0.207	<D.L.	<D.L.	0.230
70	6.209	150.8	97.52	25.90	1.292	0.426	0.162	0.095	<D.L.	0.340
71	6.135	92.18	69.69	19.52	0.917	0.076	0.196	0.025	<D.L.	0.174
72	6.228	114.5	96.93	28.57	1.006	0.057	0.183	<D.L.	<D.L.	0.265

codex and WHO/FAO reports the maximum allowed zinc-intake amount recorded as respectively 5–50 and 20 mg/kg in some vegetables and foods. While high-dose zinc amount affects chlorophyll synthesis in plants, the daily recommended zinc amount for people is specified as 15 mg [31,32]. Symptoms of acute intoxication occur, such as indigestion, diarrhea, nauseation, and stomach ache [33]. According to our measurements, in plant samples, the least zinc-amount accumulation is 0.009 mg/kg and the highest zinc-amount accumulation is 0.624 mg/kg (Table 3).

The trace cadmium amount plants can have in their structure is 0.05–0.5 mg/kg [29]. It was determined that people take daily 0.02–1 mg of cadmium with respiration. WHO advises that in open air to protect human health, cadmium concentration should not be more than 1–5 ng/m^3 in rural areas and should not be more than 10–20 ng/m^3 in urban and industrial areas [34]. High-dose cadmium causes health problems, such as hypertension, anemia, stomachache, excessive vomiting, bone fracture, reproduction and infertility, central nervous-system failures, failures in the immune system, physical breakdowns, cancer, hair shedding, skin dehydration, diminishing appetite, liver and kidney disfunctions, and shorter lifespan [35]. According to our measurements, in plant samples, the least cadmium-amount accumulation is 0.007 mg/kg and the highest zinc-amount accumulation is 0.294 mg/kg (Table 3).

Whereas cobalt excessiveness in pasture and meadow lands is poisonous for plants, in the case of cobalt, lackness in plant-structure inappetency and even deaths can be seen in ruminant animals. The trace cobalt amount plants can have in their structure is 0.02–0.5 mg/kg [29]. According to our measurements, in plant samples, the least cobalt-amount accumulation is 0.022 mg/kg and the highest zinc-amount accumulation is 0.027 mg/kg (Table 3).

Manganese surplus in plants shows poison effect and avoids plants that absorb iron. In the absence of manganese, which is also found in the structure of chlorophyll, chlorophyll generation decreases in the plants. The trace manganese amount plants can have in their structure is 20–400 mg/kg [29]. According to our measurements, in plant samples, the least manganese-amount accumulation is 0.097 mg/kg and the highest manganese-amount accumulation is 2.098 mg/kg (Table 3).

Conclusion

It has been determined that some of these samples sold under the name *A. millefolium* do not belong to this species. Five different taxa belonging to the genus *Achillea* L. have been found to be sold under the name yarrow. Samples are sold in a mixture of different taxa in the same herbalist. In this study, no case exceeding the limit values in terms of Na, K, Ca, Mg, Fe, B, Zn, Cd, Co, and Mn was observed, no evidence has been found to affect human health.

In order to determine the quality of medical plants and to prevent human health from adversely affecting them, it is necessary to determine the heavy-metal concentrations and make them a criterion for selling.

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Conflicts of interest
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