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The chamomile and linden flowers – sources of essential microelements - a review

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Abstract

Background: Medicinal plants, used for the preparation of teas, contain in addition to numerous biologically active components also significant amounts of microelements essential for the human body. That is why we considered it necessary to provide information on the intake of essential elements of chamomile and linden flowers.

Aim: To review the available to highlight the intake of essential microelements Fe, Mn, Zn and Cu) of some medicinal plants (chamomile and linden) used in the preparation of medicinal teas.

Methods: The methodology for this review involved a search from Google and Google academic from 2000 to 2021 using the key-words: "medicinal plants", "medicinal herbs", "trace elements in medicinal plants", "minerals in medicinal plans", "trace elements in human health".

Conclusion: Chamomile and linden flower contain significant amounts of Fe, Mn, Zn and Cu, their concentration showing the same decreasing trend Fe> Mn> Zn> Cu. Finally, can be stated that the chamomile and linden flowers reviewed play a meaningful role in human nutrition as micro-nutrients sources.

Keywords: Essential microelements, *Chamomile*, Tilia, Medicinal plants

1.Introduction

Chamomile (*M. chamomilla*) and linden (*Tilia cordata*) are among the best known and most widely used medicinal plants for making teas, with a beneficial impact on health [1,2]. They are used for medical purposes to prevent or treat many ailments: calming, improving digestive problems, increasing energy levels and invigorating the body, avoiding colds, stimulating the functioning of internal organs, reducing stress, detoxifying the body, increasing immunity, being also a source of antioxidants, oligoantigens, etc. [3, 4, 5]. Beneficial effects of these plants is due to the diversity of biologically active substances from their composition: alkaloids, tannins, oils, vitamins, minerals, etc. [5, 6, 7].

Chamomile and linden contain significant amounts of iron, manganese, zinc and copper, microelements that although present in low concentrations, have vital roles in the growth, development and general well-being of the human body. They play a crucial role in many biochemical processes, the microelements being basic components in the structure of vitamins and enzymes [8]. Their presence in insufficient quantities or above certain concentration limits may negatively affect the normal functioning of the body, causing many fatal diseases [6]. The human body needs small amounts of essential microelements, ranging from 50 ug to 18 mg per day [9]. Previous studies show that essential trace elements play an important role as a cofactor for certain enzymes involved in metabolism and cell growth, many of which are involved in the metabolism of proteins, carbohydrates, lipids and energy [10]. These are necessary for growth, development, muscle and nerve function, normal cell function and the synthesis of hormones and connective tissue [8].

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Iron is one of the most important and abundant microelements present in body cells. It is a component of myoglobin and hemoglobin, functions as a carrier of oxygen in the blood and muscles and is indispensable for the synthesis of hormones and connective tissue, as well as for the development, growth and normal functioning of cells and has a central and critical role in the synthesis of many proteins involved in iron metabolism [8].

Manganese is an essential microelement that is associated with the activation and synthesis of various enzymes (isomerases, hydrolases, ligases, transferases, lyases, oxidoreductases, glutamine synthetase, pyruvate decarboxylase and arginase), accelerating protein synthesis, vitamins B and C synthesis, regulating blood sugar and endocrine system; improving immune function, catalyzing hematopoiesis and works (along with vitamin K) to support blood clotting and blood pressure control [8].

Zinc, an essential microelement involved in a large number of enzymes or stabilizers of the molecular structure of subcellular constituents and membranes, plays an important role in cell proliferation, differentiation and metabolic activity of the cell and supports normal growth and development [9]; it also plays a key role in the processes of gene expression and plays an important role in human growth and development during pregnancy, childhood and adolescence [8].

Copper is one of the essential microelements that are needed to support the biological functions of the human body, being part of many enzymes (cytochrome oxidase, monoamine oxidase, catalase, peroxidase, ascorbic acid oxidase, lactase, tyrosinase and superoxide dismutase) and copper-dependent proteins [8, 10]; it is also associated with iron in the formation of red blood cells [8].

Given the distribution of these essential microelements in linden and chamomile as well as their role in metabolism, we consider it very important to know the contribution of these medicinal plants to ensuring the necessary Fe, Mn, Zn and Cu. This paper aims at a review, based on available documentation, of the distribution of Fe, Mn, Zn and Cu in chamomile and linden flowers and the evaluation of their contribution with such essential microelements.

2. Results and discutions

2.1. Chamomile (Matricaria chamomila)

Chamomile (*Matricaria chamomilla*) is one of the most popular and widely used herbs in the world. It is notable for its content of volatile oils, sesquiterpene (proazulene) bitter principles, flavonoids (apigenin glycosides, luteolin, kaempferol and methoxylated derivatives), carbohydrates, vitamins (B1, C, carotenoids), choline, minerals (calcium, iron, zinc, silicon, molybdenum, copper, phosphorus, potassium), fatty acids (oleic, linoleic, palmitic, stearic, cerotic acid), phenolic acids (chlorogenic, caffeic, salicylic, syringic, vanillic) [1, 11]. Due to the high content of phenolic compounds and essential oils, chamomile flower preparations have a number of pharmacological effects, including antioxidant, anti-inflammatory, antimicrobial and sedative actions, anticancer, neuroprotective and improved gastrointestinal function, improves cardiac health, etc. [12, 13, 14]. Chamomile flowers have antioxidant, anti-inflammatory, antiseptic, antispasmodic and sedative effects [11, 13]. As a traditional medicine, it is used to treat wounds, ulcers, abdominal colic, dyspepsia and diarrhea, nephritis, eczema, gout, skin irritations, burns, canker sores, neuralgia, sciatica, abdominal and rheumatic pain, hemorrhoids, mastitis, but also sedative [1, 15]. Chamomile is recommended in acute and chronic infections of the digestive tract (hyperacid gastritis, gastric ulcer, enterocolitis, diarrhea), respiratory tract (flu, colds, bronchitis, tracheitis, asthma), urogenital disorders (cystitis, vaginitis, prostatitis, leukorrhea), painful periods (through antispasmodic, analgesic action), kidney disease (promotes the elimination of urate, uric acid), fights gout, arthritis, rheumatism, fights insomnia, anxiety, depression, etc. [16].

The nutritional and therapeutic quality of chamomile is also given by the content of Fe, Mn, Zn and Cu which are in the composition of this precious medicinal plant. The concentration of iron, manganese, zinc and copper in chamomile, according to the information from the reviewed studies is presented in Table 1. These data show that the distribution of these essential microelements in chamomile shows marked unevenness, depending on the origin of chamomile and the nature of the element. These differences can also be determined by the processing mode and analysis techniques used to determine the microelements.

Table 1. Distribution of the Fe, Mn, Zn and Cu in chamomile (*Matricaria chamomilla*)

No.	Specification	Element, mg/kg DM				Ref.
		Fe	Mn	Zn	Cu	
1	Herbalists and markets, Turkey	502.7±3.0	60.2±3.3	30.6±2.1	8.34±0.05	[17]
2	Packed by “Bioprogramme”, Bulgaria	565±10 - 567±5	135±3 – 137±5	43±2 -45±2	-	[18]
3	Market, Romania	335.80±0.006	16.60±0.009	6.63±0.005	4.82±0.001	[19]
4	Katowice markets, Poland	15.7±0.2	13.8±0.1	88.8±0.5	1.38 ±0.01	[16]
5	Fron the flore,East Romania	291.8±5.73	158.0±14.33	104.8±15.24	37.6±6.58	[20]
6	Local market, Romania	1440	135	45,6	10,23	[5]
7	Local market, Romania	598	116	43.8	21.3	[21]
8	Market, Romania	244	65	17.2	7.7	[22]
9	Local pharmacy, Poland	207,7-407,5	-	-	19,3-25,5	[23]
10	Llocal super markets in Serbia	506.7	69.3	24.4	8.85	[24]
11	From bazar Turkey	244.5±60.70	36.33 ± 8.59	26.00 ± 6.28	7.40±1.78	[25]
12	Spontaneous NW Romania flora	144 ± 5.56	219 ± 5.95	22.4 ± 1.36	11.2±0.078	[26]
13	Spice wholesalers and spices shops,Turkey	350.0±42.5	45.7±3.45	34.3±3.56	10.0±1.70	[27]
14	Kayseri markets, Turkey	716± 65	841.6± 3.0	22.2± 0.8	13.9± 0.5	[28]
15	Local market, Poland	274-1020	-	24.7- 33.1	14.3- 26.5	[29]
16	Urban region, Bulgaria	894.8 ± 13.8	70.16± 0.74	87.92 ± 1.18	32.60±0.17	[30]
17	Rural region, Bulgaria	265.16 ± 2.29	26.45 ± 0.12	62.51 ± 0.39	13.45±0.03	[30]

Iron is the most abundant compared to Mn, Zn and Cu. In the revised studies, the Fe concentration distribution shows obvious non-uniformity, the concentration limits being between 15.4 mg/kg (in chamomile from Katowice markets [16]) and 1440mg/g (in chamomile from Romania local markets [5]). Higher concentration values were reported (mg/kg) in chamomile in Romania (1440, in local markets [5]), Poland (274-1020, in local market, Poland [29]), Bulgaria 894.8 (in urban area [30]) and Turkey (716, in Kayseri markets [28]). Lower concentrations of Fe (mg/kg) can be seen in chamomile flower samples from Bulgaria (565 – 567), packeted by “Bioprogramme” [18] and 265.16, in rural region [30]**,** Romania (598, in local market [21]; 335.8, in local market [19]; 291.8, in the East Romania flora [20]; 244, in local markets [22]), Serbia (506.7, from local super markets [24]),Turkey (502.7, in herbalist markets [17]; 350.0, from spice wholesalers and spices shops, Turkey [27]; 244.5, from bazar [25]) and Poland (207,7- 407,5 [23]). Chamomile from Romania and Poland has the lowest concentration levels (144 mg/kg, from spontaneous flora NW Romania [26], respectively 15.4 mg/kg, in Katowice markets [16]).

The permissible limit for Fe set by WHO (1999) in edible plants was 20 mg/kg [27].

After comparison of Fe limits in the review studied with those proposed by WHO, it was found that, except for chamomile in Katowice markets, all chamomile plants accumulated Fe above this limit.

Manganese is present in concentrations between 13.8 mg/kg (in chamomile from Katowice markets Polonia [16]) and 846,1 mg/kg (in chamomile Kayseri markets – Turkey [28]). The highest concentrations (mg/kg) of Mn have been reported in chamomile in Turkey (841.6, in markets from Kayseri [28]), Bulgaria (135-137, packed by “Bioprogramme” [18]) and Romania (219, from spontaneous flora NW Romania, [26]; 158, in the East Romania flora [20]; 135, from local markets [5]; 116, from local market [21]). This trace element is present in lower concentrations (mg/kg) in chamomile samples in Bulgaria (70.16, from urban area [30]), Serbia (69.3, from local supermarkets [23]), Turkey (60.2 and 45.7 mg/kg, in local herbalists and markets [17], respectively from spice wholesalers and spices shops [27]) and Romania (65, in Romanian market [S22]). The lowest concentrations of Mn (mg/kg] are recorded in chamomile flowers in Turkey (36.33, in bazar [25]), Bulgaria (26.45, rural region [30]), Romania (16.6, from local market [19]) and Poland (13.8, from Katowice markets [16]).

The permissible limit set by WHO (1999) in edible plants was 2 mg Zn/kg plant [27]. After comparison of Mn limits in the review studies with those proposed by WHO (1999), it was found that all plants accumulated Mn above this limit.

Zinc. The reviewed studies (Table 1) show that the concentration limits of Zn in chamomile flowers have values between 6.63 mg/kg (in local markets from Romania [19]) and 104.84 mg/kg (in the East Romanian flora [20]). The highest values (mg/kg) are identified in chamomile from Romania (104.84, in the East Romania flora [20]), Poland (88.8, in Katowice markets from Poland [16] and Bulgaria (87.92, in urban region and 62.51 mg/kg in rural region [30]). Lower values of Zn (mg/kg) are recorded in chamomile samples analyzed in Romania (45.6 and 43.8, from local markets [5, 21]), Bulgaria (43-45, packed "Bioprogramme" [18]), Turkey (34.3, from spice wholesalers and spices shops [27]; 26, in bazar [25]; 30.6, in local herbalists and markets [17]), Serbia (24.4, in supermarkets [24]), Romania (22.4, from spontaneous NW Romania flora [26]) and Turkey (22.2, in local markets in Kayseri [28]). The lowest concentrations of zinc are found in chamomile samples analyzed in Romania (17.2 and 6.63, in local markets [19, 22]) and Bulgaria (13.45, in rural region [30]).

The permissible limit set by WHO (1999) for edible plants was 27.4 mg Zn/kg plant [27]. After comparison of Zn limit in the reviewed studies with those proposed by WHO (1999), it was found that Matricaria chamomilla L from Serbia (24.4, in supermarkets [24]), Romania (22.4, from spontaneous NW Romania flora [26]) and Turkey (22.2, in local markets in Kayseri [28]), Romania (17.2 and 6.63, in local markets [22, 19]) and Bulgaria (13.45, in rural region [302021]) are below this limit while all others accumulated Zn above this limit.

Copper was determined in much lower concentrations than Fe and Mn and lower than Zn. The distribution of this essential element in the chamomile flowers analyzed in the reviewed studies is uneven, the concentration limits being between 1.38 mg/kg (in Katowice markets [16]) and 37.6 mg/kg (in the East Romania flora [20]). Richer in Cu (mg/kg) are the chamomile flowers from Romania (37.6, in East Romania flora and 21.3, in local markets [20, 21]), Bulgaria (32.6, in urban region [30]), and Poland (19.3-25.5, in local pharmacy and 14.3-26.5, in local market [29, 23]). Lower concentrations (mg/kg) of Cu are observed in chamomile from Turkey (13.9, from local markets in Kayseri and 10, in spice wholesalers and spices shops [28, 27]), Bulgaria (13.45, in rural region [30]), Romania (11.2, in spontaneous NW Romania flora and 10.73, in local markets [26, 5]), Serbia (8.85, in local supermarkets [24]), Turkey (8.34, in local herbalists and markets and 7.40, from bazar [17, 25] and Romania (7.7, in local market [22]). The poorest in Cu are the chamomile flowers analyzed in Romania (4.82, in local markets [19] and Poland (1.38, in Katowice markets [16]).

From the presented data it can be stated that iron is the most abundant of the microelements. Manganese has been reported in lower concentrations than Fe, but much higher than Zn and Cu. Compared to copper, zinc is present in lower concentrations. Therefore, the concentrations of trace elements reported in the reviewed studies show the following decreasing trend: Fe (15.4 - 1440 mg/kg) >Mn (13.8 – 841.6 mg/kg)> Zn (6.63 - 104.84 mg/kg)> Cu (1.3 - 37.6 mg/kg).

The permissible limit set by WHO (1999) for edible plants was 3.00 mg Cu/kg plant [27]. Comparing the values reported in this study with the permissive limit, it is observed that except for the chamomile from Katowice markets, the other chamomile samples accumulate all above this limit. Given the maximum concentration levels of Fe, Mn, Zn and Cu in the reviewed chamomile (Table 1), and recommended daily requirement and tolerable levels of this microelements (Table 2) [31] can be considered as a moderate consumption of infusion of chamomile (2-3 cups of tea, corresponding to approximately 6 g of dried chamomile), does not pose a risk to the human health. Moreover, under these conditions, this medicinal plant can provide an important part of the daily requirement of Fe, Mn, Zn and Cu.

Table 2. Summary Report of the Dietary Reference Intakes [31]

Specification	People raged	Mineral element, mg/day			
		Mn	Fe	Zn	Cu
Recommended values	Man	2.3	8	11	0.9
	Woumen	1.8	18	8	0.9
Tolerable values	Man	11	45	40	10
	Woumen	11	45	40	10

2.2. The linden flowers

Linden flowers and especially bracts contain mucilaginous substances, farnesol, flavonoids, tannins, vitamins, triterpene substances and even sucrose [32]. These beautiful, fragrant and prized flowers have been used since ancient times for colds, fevers, have anti-inflammatory effects, cause sweating, relieve coughs and have a mild sedative effect [33, 34]. Linden flowers contain: carbohydrates, sterols, tannins, oxidase, vitamin C, volatile oil, sugar, choline, acetylcholine, a specific compound called tyrosine [35]. Linden flowers also contain flavonoids and polyphenols, alkaloids and other phytochemicals [36, 37]. In addition, linden flowers also contain significant amounts of essential mineral elements, which complement the nutritional and therapeutic qualities of this plant [2, 21]. The inflorescences (Tiliae flos cum bracteis) of the Tilia tree from the Tiliaceae family are among the most well-known and used medicinal plants. The beneficial effects and therapeutic qualities of linden flowers are due to nutritionally and biologically active compounds with different structures and remedial powers, such as alkaloids, tannins, oils or vitamins, minerals that are part of their composition [16]. Linden flower is stated to possess sedative, antispasmodic, diaphoretic, hypotensive, emollient, diuretic and mild astringent properties and it has been used for migraine, hysteria, arteriosclerotic hypertension, feverish colds, and specifically for raised arterial pressure associated with arteriosclerosis and nervous tension [32, 38, 39]. They are used in traditional medicine in colds, respiratory diseases and migraines, but also as a sedative, antispasmodic, antioxidant and hepatoprotective effects [40, 41, 46-48]. The linden flowers infusion also has the property of fluidizing and purifying the blood, reducing toxicity in the body. In internal therapy, the infusion of linden flowers is necessary in cases of flu, colds, bronchitis, whooping cough, insomnia, hypochondria, nervousness, severe brain fatigue, digestive disorders on the nervous background, muscle pain, arteriosclerosis, kidney pain [16, 35, 40, 42]. These biologically active compounds from linden flowers make it possible to use these plants in obtaining phyto-improved foods with superior nutritional and organoleptic characteristics [43]. Studies on the mineral profile of reviewed linden flowers show that they are used in the preparation of medicinal teas or other medicinal preparations, contain significant amounts of Fe, Mn, Zn and Cu, which through their functions in the human body, contribute to the growth of therapeutic and nutritional value for this medicinal plant (Table 3). As can be seen from Table 3, the concentrations of trace elements: iron, manganese, zinc and copper in linden flowers reported in the reviewed studies show obvious non-uniformity depending on its origin and the nature of the trace element.

Table 3. The concentration of the Fe, Mn, Zn and Cu in Linden flowers

No.	Specification	Element, mg/kgDM				Ref.
		Fe	Mn	Zn	Cu	
1	Herbalists and markets, Turkey	228±26	71.2±1.5	35.6±2.2	9.64±0.76	[17]
2	Katowice markets Poland	8.41±0.05	36±0.10	55.1± 0.4	1.58± 0.02	[16]
3	Markets, Romania	214	98.6	24.4	9.25	[21]
4	Markets, Romania	113	73	13.5	8.0	[22]
5	Pharmacy, Poland	154,5-64,3	-	-	14,8-15,5	[23]
6	Markets, Poland	55.5±0.1	38.8±0.2	25.0±0.3	6.09±0.10	[44]
7	Bazar, Turkey	39.2±6.34	4.88±0.70	8.26±2.61	0.31±0.14	[25]
8	Spontaneous NW flora, Romania	64.9±6.23	71.9 ±3.77	18.8 ±1.07	9.22 ± 0.066	[26]
9	Kayseri markets, Turkey	186± 1	123± 5	25.8± 1.4	19.1± 0.3	[28]
10	Urban area, Bulgaria	58.93 ± 0.29	19.61±0.18	8.60 ±0.04	8.90 ± 0.07	[30]
11	Rural region, Bulgaria	26.77 ± 0.13	18.51±0.19	7.27 ±0.07	7.09 ± 0.06	[30]
12	Trees from Izmir, Turkey	175±10 – 196±20	36±8.00- 39±8.5	22±2.5 - 30±2.80	15±1.5- 16±1.4	[40]
13	Spontaneus, flora, Turkey	220.7±90.8	32.7±10.5	24.0±2.68	10.3±4.1	[27]
14	Trees from Chisinau, Moldova	23.0	-	9.2	-	[45]
15	Packed by "Jaka-80", Macedonia	296	119	17.0	-	[18]

With a few exceptions, iron and manganese have been reported in the highest concentrations. Zinc and copper have lower concentrations.

Iron was reported to be in the concentration range of 8.41 (in Katowice markets, Poland) – 296 mg/kg linden flower, in Macedonia markets [16, 18]. The highest values of iron (mg/kg) are recorded in linden flowers in Macedonia (296, packed by "Jaka-80" [18]), Turkey (228, in local herbalists and markets; 220.7, in spontaneous flora; 186.1, in Kayseri markets; 175-196, in trees from Izmir [17, 27, 28, 40]), Poland (154.5-164.3, in dried plants from pharmacy [23]), Romania (214 and 113, in local market [21, 22]). Lower iron concentrations (mg/kg) are recorded in the case of linden flowers in Romania (64.9, in spontaneous flora from NW Romania [26]), Bulgaria (58.93, in urban region and 26.77, in rural region, [30], Poland (55.5, in Polish markets [44]), Turkey (39.2, in bazar [25] and Republic of Moldova (23, trees from Botanical Garden - Chisinau [45]. The lowest Fe content was reported in linden flowers from Poland (8.41, from Katowice markets [16]. The permissible limit set by WHO (1999) in edible plants was 20 mg Fe/kg plant [27]. Comparing the linden flower Fe concentrations reported in the reviewed studies (Table 3) with this limit, it can be observed that except for linden flowers from Katowice markets, all linden herbs accumulated Fe above this limit.

Manganese. The reviewed studies reveal that the distribution of manganese in the linden flower is uneven, the concentration limits being between 4.88 mg/kg from bazar [25] - 123 mg/kg, from Kayseri markets in Turkey [28]**.** The richest in Mn (in mg/kg) are the linden flowers on the market in Turkey (123, from Kayseri markets and 71.2, herbalists and markets [28, 17]), Romania (98.6 and 73, from local markets and 71.79, from NW Romania flora [21, 22, 26]) and Macedonia (119, Packed by "Jaka-80 [18]). Lower concentrations of manganese are recorded in linden flowers in Turkey (36-39, from Izmir trees and 32.7, from spontaneous flora [40, 27]), Poland (38.8, from Polish markets [44]) and Bulgaria (19.61 and 18.51 from urban, respectively rural zone [30]). In linden flowers from Poland and Turkey, the lowest Mn content was identified (6.36, from Katowice markets, respectively 4.88, from bazar [16, 25].

The permissible limit set by WHO (1999) in edible plants was 2 mg Mn/kg plant [27]. Comparing the Mn concentrations of linden flower reported in the reviewed studies (Table 3) with this limit it was found that all linden flowers accumulated Mn above permissible limit.

Zinc. The concentration of this microelement in linden flowers in the reviewed works (Table 3) shows values between 7.27 mg/kg (in linden flowers in rural areas of Bulgaria [30] - 55.1 mg / kg (in linden flowers from Katowice markets in Poland [16]) Higher values of Zn content (mg/kg) were reported in linden flowers in Poland (55.1, from Katowice market [16], 25.0, in markets [44]) and Turkey (35.6, from 25.8, from markets in Kayseri; 22 - 30, Izmir trees; 24.0, in spontaneous flora [17; 28; 40; 27]). Lower values (mg/kg) of zinc concentration may observed in linden flowers in Romania (18.8, from spontaneous NW Romania flora; 13.5, from markets [26, 22]) and Macedonia (17.0, Packed by "Jaka-80" [18]). Zinc (mg /kg) were identified in linden flowers from the Republic of Moldova (9.2, in trees from Botanical Garden in Chisinau [45], Bulgaria (8.60 in urban areas and 7.27 in rural areas [30]) and in Turkey (8.26, from - bazaar [25]). The permissible limit for Zn set by WHO (1999) for edible plants was 27.4 mg/kg plant [17]. After comparison of Zn limit in the reviewed studies with those limits, it was found that linden flowers from Katowice markets - Polonia [16], herbalists and markets – Turkey [17] and from Izmir –Turkey [40] accumulated Zn above this limit. The concentration of all other linden flowers in NW Romania flora [26] and from local markets in Kayseri - Turkey are below permissible limit.

Copper. The copper concentration from reviewed works show lower values than Fe, Mn and Zn concentrations and show values between 0.31 in the bazaar - 19.1 mg/kg from local markets in Kayseri, Turkey [25, 28]. Linden flowers from Turkey (19.1 mg/kg from local markets in Kayseri; 15-16 mg/kg from Izmir trees [28, 40]) and Poland (14,8-15.5 from pharmacy [23]) have the highest copper contents. Lower copper concentrations were reported from linden flowers in Turkey (10.3 in spontaneous flora; 9.64 in herbalist markets [27; 17], Romania: (9.26 and 8.0 in local markets [21, 22]), Bulgaria (7.09 in rural regions and 8.90 in urban region [30] and Poland (6.09 in Polish markets [44]. The lowest amounts of copper were identified in linden flowers in Poland (1.58 in Katowice markets [16]) and Turkey. (0.31 from bazaar [25]).

As can be seen from Table 3, iron is the predominant microelement in linden flowers analyzed in the studies of this review. Manganese has been identified in lower concentrations than Fe, but higher than Zn and Cu. Copper is the least represented element, it is reported in much lower concentrations than Fe and Mn and lower than Mn. Concentrations of the essential microelements in the sampled linden flower show the following decreasing trend: Fe (8.41-296 mg/kg)> Mn (4.88-123 mg/kg)> Zn (7.27-55.1 mg/kg)> Cu (0.31 - 9.1 mg/kg).

The permissible limit set by WHO (1999) for edible plants was 3.00 mg Cu/kg plant [27]. Comparing the values reported in this study (Table 3) with the permissive limit, it is observed that except for the chamomile from Katowice markets – Poland [16], the other chamomile samples accumulate all above this limit. Analyzing the concentrations of Fe, Mn, Zn and Cu from the linden flowers reported in the reviewed studies (Table 3), the recommended daily requirement and the tolerable levels of Fe, Mn, Zn and Cu (Table 2), it can be observed that a consumption of 2-3 cups of linden tea, which would correspond to about 6 g of dried plant, does not constitute a risk of contamination with such mineral elements. In addition, a moderate consumption of tea is considered beneficial for providing the daily necessities with essential microelements.

3. Conclusions

The nutritional and therapeutic qualities of chamomile (Matricaria chamomila) and linden flowers (Tilia cordata), two of the most widely used medicinal plants, are also due to their content of essential microelements. These highly prized herbs also contain significant amounts of Fe, Mn, Zn and Cu distributed in concentration limits of the order of mg/kg - g/kg. The concentrations of microelements in the two reviewed medicinal plants follow the same decreasing trend Fe> Mn> Zn> Cu. Iron is the most abundant trace element, followed by smaller amounts of Mn and much smaller Zn and Cu.

Comparing the concentrations of microelements in the reviewed medicinal plants, it is observed that, compared to the linden flower, chamomile is richer in Fe, Mn, and Cu. Therefore, chamomile is better represented in terms of mineral intake. With some exceptions, the concentrations of microelements in chamomile and linden flowers exceed the permissible levels for Fe, Mn, Zn and Cu in the chamomile and linden flowers reviewed, as well as the need and tolerable limits of these elements. It can be stated that a moderate consumption of chamomile or linden flower infusion (5-6 g dried plant), provides a good part of the necessary Fe, Mn, Zn and Cu. It is necessary to know precisely the content of these essential microelements, which above certain concentration limits can have undesirable effects on health.

Finally, from the above presented data of the reviewed linden and chamomile flowers, we can say that they are playing a meaningful role in human nutrition as micro-nutrients sources**.**

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human or animal subjects (if exist) respect the specific regulation and standards.

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