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The potential hazard of consuming bundles of leafy edible minor crops: agricultural weeds

Yaprağı yenen minör ürün demetlerindeki potansiyel tehlike: tarımsal yabancı otlar

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ABSTRACT

Minor crops (parsley, mint, rocket, etc.), which are leafy edible vegetables, are among the indispensable consumption products of tables in Türkiye. These products, grown for their rich and nutritious content, can be eaten raw or cooked. In agricultural areas, weeds prevent the development of minor crops and reduce yields and product quality if not controlled. Weeds grown at the same time as these products reach the markets in bundles with the products during the harvest and from the markets to the tables. Intensive consumption of weeds accidentally mixed into the bunch can cause some undesirable health problems, such as poisoning. In this study, the contamination rates of the minor crop bundles purchased periodically in different periods from the public bazaar of two different districts (Çukurova and Seyhan) in the province of Adana between 2021-2023 were determined. A total of 135 minor crop bundles were purchased over two years and 36 different weed species were recorded. It was found that the contamination rate of the total weeds was 50.37% and the most contaminated species were *Cyperus rotundus* L. (8.15%), *Convolvulus arvensis* L. (6.67%), *Portulaca oleracea* L. and *Setaria viridis* (L.) P. Beauv (3.70%). The study was carried out to determine the level of contamination of the consumed bundles with plant parts and the toxicity potential (according to previous studies on harmful components and toxins) of the weed species found in these bundles on health.

INTRODUCTION

Minor crops (purslane, parsley, rocket, cress, mint and dill), which are leafy edible vegetables, are among the most important products consumed daily, both raw and cooked, on the tables of almost every region of Türkiye. As well as being consumed as roots and leaves of small, nutritious plants, some essential oils are used in the pharmaceutical and cosmetic industries (Charles 2012, Gupta et al. 2012, Nemzer et al. 2020, Taneja and Chandra 2012, Telci et al. 2004, Vural et al. 2000, Zheljazkov et al. 2009). These products, which occupy an important place on the table, are widely consumed in the Aegean and Mediterranean regions of the country. According to the 2021 data, the cultivation of these products in Türkiye amounted to 193841 tonnes on an area of 13.318 ha. The Mediterranean region accounts for about 44% of this area and production, the Marmara region for 31%, the Aegean region for 7% and the Black Sea region for 5% (TUIK 2021).

For minor crops, sowing is done by hand or by repeated sprinkling in pans in small fields, and by machine in large fields. Irrigation after sowing ensures the germination of minor crop seeds and increases the emergence of weeds. Removing weeds is one of the most important management practices (Borowy 2013, Charles 2012, Gupta et al. 2012, Karkanis et al. 2018, Taneja and Chandra 2012, Vural et al. 2000). Failure to control weeds, which have become major pests in agricultural areas, can lead to serious losses in crop yield and quality (Gharde et al. 2018, Pimentel et al. 2005). *Amaranthus retroflexus* L., *Capsella bursa-pastoris* (L.) Medik., *Chenopodium album* L., *Convolvulus arvensis* L., *Conyza canadensis* (L.) Cronquist, *Cuscuta campestris* Yuncker, *Cyperus rotundus* L., *Datura stramonium* L., *Echinochloa colonum* (L.) Link, *Echinochloa crus-galli* (L.) P. Beauv., *Heliotropium europaeum* L., *Hibiscus trionum* L., *Lamium amplexicaule* L., *Matricaria chamomilla* L., *Orabanche ramosa* (L.) Pomel., *Poa annua* L., *Polygonum aviculare* L., *Portulaca oleracea* L., *Sinapis arvensis* L., *Solanum nigrum* L., and *Urtica urens* L. are some of the important weed species in minor crop areas in the world and in Türkiye (Borowy 2013, Karkanis et al. 2012, Sokat 2019, Sokat 2021, Torun 2017, Üstüner 2022a).

Although pesticides have been preferred for their ease of use and economy in growing crops in a short time for the world's population against the pests (pathogens, insects, weeds, etc.) that are a problem in agriculture, the current increase in pesticide consumption has led to an increase in the number of residues in products and, therefore, to adverse human effects and diseases (Bassil et al. 2007, Bradlow et al. 1995, Snedeker 2001, Weichenthal et al. 2010). With these increasing problems, it has become necessary to develop healthier, different and alternative control strategies to manage crop pests in cultivation. The use of pesticides for control is limited for reasons such as the short harvesting period for fresh leaf consumption of minor crops, and the small size of the growing area.

The lack of weed control options in minor crops can lead to an increase in weed populations over time. In parallel with the increase in weed populations, plant parts that are mixed into bundles at harvest are transported to markets. Cases of poisoning may also occur in urban areas as a result of unintentional or involuntary mixing of weed species similar in early development with minor crops and excessive consumption. Worldwide, seeds or leaf parts of some plant species, such as *Arum maculatum* L. (Öztürk et al. 2008, Şimşek Yurt et al. 2019), *Atropa belladonna* L. (Demir et al. 2006, Hagemann et al. 1992), *Datura stramonium* L. (Deniz et al. 2004, Nalbantoğlu et al. 2017, Türkseven et al. 2021), *Solanum dulcamara* L. (Gümüşçü and Gümüşçü 2012), appear to cause human poisoning when consumed. In fact, it has been reported that in Adana province of Çukurova region, plants chemical poisoning in human food accounts for about 2-4% of poisoning cases (Özkale and Özkale 2020, Yöntem et al. 2021). In addition to the proliferation of these poisonous plants in agricultural and natural areas, their accidental or unintentional consumption is increasing every day (Anonymous 2025, Balabanlı et al. 2006, Gül and Topçu 2017, Sokat 2021, Töngel and Ayan 2005). There are plant toxins in the plant body that contain harmful components in varying amounts and ratios. They contain different groups of plant constituents that can be toxic, such as alkaloids, glycosides, nitrates and nitrites, oxalates, phenolic compounds, proteins, resins/resinoids and tannins, depending on the developmental stage of the plant (Chandra Sekhar et al. 2012, Friday 2019, Institute of Medicine and National Research Council 2005, Öztürk et al. 2008, Sokat 2021). A number of scientific case report studies conducted in Türkiye have revealed that poisoning is caused by dangerous levels of tropane alkaloids such as atropine, hiyasiyomin and scopolamine (Nalbantoğlu et al. 2017, Yöntem et al. 2021). For this reason, the morphology of the weed species causing poisonings and their potentially toxic contents must be known by consumers (Barile 2010, DiTomaso 2000, Friday 2019, Patel et al. 2013, Türkseven et al. 2021).

The study was conducted to determine the contamination levels of weed species found mixed in minor crop bundles sold in urban areas, and to determine the relationship between the toxicity of the studied plant species and health.

MATERIALS AND METHODS

Location and sampling

The study was conducted between March 2021 and February 2023 in two different central districts (Çukurova-37°02'27.1"N 35°18'12.5"E and Seyhan-37°01'36.4"N 35°18'24.9"E) where the urban population is concentrated in the Çukurova region of Adana province in a fixed public bazaar. Samples were taken from the same bazaar stall and bundles were collected weekly (monthly sampling continued) in two different locations. Each week, the minor crop available at the same stand was randomly selected. Bundles were purchased from vendors selling the same minor crops (parsley, mint, rocket, etc.) in the weekly public bazaar, and attempts were made to identify weed parts in the bundles taken home that had been identified during the cleaning of the produce bundle.

Sample evaluation

Care was taken to ensure that the bundle samples were representative of the district, and bundles of minor crops were purchased from designated bazaar at regular intervals (Nkoa et al. 2015). Plant parts were identified in the laboratory using the Flora of Turkey (Davis 1965-1988).

In the present study, beam sampling was modified according to Odum (1971) and the contamination ratio (%) was determined. The contamination ratio was determined as the percentage of a plant species part detected in the purchased bunch. The contamination ratio was determined as (N) one contaminated pile of minor crops and (M) total sampling as one pile of minor crops (Equation 1).

Contamination ratio (%)=N/M*100 (Equation 1)

The aim was to find out which species of weeds are inadvertently consumed by the people of the province who buy small crops in Çukurova and Seyhan, the central districts of Adana where the urban population is dense, in the previously identified public bazaar, and the potential toxicity of the weed species they are exposed to.

RESULTS AND DISCUSSION

Detection of contamination in minor crop bundles

The study was conducted with minor crop bundles purchased weekly (periodically) for two years from two different public bazaar previously identified in Çukurova and Seyhan central districts between March 2021 and the end of February 2023. The vegetative parts of the weed species mixed during washing were determined and identified in the minor crop bundles taken in this way. In the first year 32 out of 60 bundles were found to be mixed at a rate of 53.33% and in the second year 36 out of 75 bundles were found to be mixed at a rate of 48.00%. The highest crop-specific contamination rate was observed for dill in the first year and for parsley in the second year. The highest levels of contamination were found in rocket (54.54%) and parsley (52.94%) in both years in the minor crop bundles. Although a contamination rate of 57.14% was found in the bundles bought at the bazaar in Çukurova district, this rate was found to be 39.21% in Seyhan district (Table 1).

In the first year 21 species of 14 families (39 times in total) were identified, in the second year 26 species of 17 families (45 times in total) and in total 20 different families were identified. From 2021 to 2022, although Poaceae was the richest family with 5 different species (23.81%), the family with the highest contamination ratio in total bundles was Cyperaceae (8 times) with 20.51%. In 2022-2023, the family Poaceae was again the richest with 4

Table 1. Mixing numbers and contamination ratios (%) in the total sampled minor crop bundles

Sampling year	Sampling minor crops	Number of bunches						%
		Çukurova Bazaar		Seyhan Bazaar		Total		
		Sampling	Contaminated	Sampling	Contaminated	Sampling	Contaminated	
2021-2022	Cress	1	0	0	0	1	0	0.00
	Dill	2	1	1	1	3	2	66.67
	Mint	7	4	5	3	12	7	58.33
	Parsley	21	14	12	4	33	18	54.55
	Purslane	2	0	1	0	3	0	0.00
	Rocket	4	3	4	2	8	5	62.50
	Total	37	22	23	10	60	32	53.33
2022-2023	Cress	1	0	3	2	4	2	50.00
	Dill	1	0	0	0	1	0	0.00
	Mint	16	8	5	1	21	9	42.86
	Parsley	17	11	18	7	35	18	51.43
	Purslane	0	0	0	0	0	0	0.00
	Rocket	12	7	2	0	14	7	50.00
	Total	47	26	28	10	75	36	48.00
Total	Cress	2	0	3	2	5	2	40.00
	Dill	3	1	1	1	4	2	50.00
	Mint	23	12	10	4	33	16	48.48
	Parsley	38	25	30	11	68	36	52.94
	Purslane	2	0	1	0	3	0	0.00
	Rocket	16	10	6	2	22	12	54.54
	Total	84	48	51	20	135	68	50.37

different species (15.38%), but the highest contamination ratio in bundles was found in the families Poaceae and Convolvulaceae (7 times each) with 15.56%. It was also found that more than one different plant species could be mixed in some minor crop bundles (Table 2). Some of the weed families belonging to the species found in the bazaar samples may be from the species commonly found in agricultural areas in the list published by the Ministry of Agriculture and Forestry of Türkiye, including *Convolvulus* sp. (root, resin-Convolvulaceae), *Datura* sp. (root, flower, seed, leaf-Solanaceae), *Ecballium* sp. (fruit, fruit usar, root-Cucurbitaceae), *Cyperus* sp. (tuber-Cyperaceae), *Ipomoea* sp. (root, resin-Convolvulaceae), *Papaver* sp. (head, whole plant- Papaveraceae), *Senecio* sp. (flower, whole plant, root-Asteraceae) and *Solanum* sp. (whole plant, fruit-Solanaceae) should definitely not be consumed and pose a risk to human health because they contain toxic compounds (Anonymous 2025). In another study reported that the atropine content of *Datura* sp. in Solanaceae family mixed in spinach bundles caused poisoning in humans (Türkseven et al. 2021).

Weed species found in minor crop bundles and their toxicity potential

In terms of weed species, the highest contamination rate was recorded for *Cyperus rotundus* L., with 8.15% in minor crop bundles. This is followed by *Convolvulus arvensis* L. with 6.67%, followed by *Portulaca oleracea* L. and *Setaria viridis* (L.) P. Beauv with the same level of contamination (3.70%) (Table 3). The vegetative weed parts mixed into the bundles generally consisted of leaves and stems (Figure 1). Flowering or seed parts of some plant species were found during sorting. Weeds that are unnoticed at the beginning of the harvest and are cut like products can be found in bundles and reach the bazaar and from the bazaar to the tables. Plant parts of *Cyperus rotundus* L. (13.33%) were observed in the first sampling year and *Convolvulus arvensis* L. (9.33%) in the second sampling year (Table 3). It is important to know the effects on humans of the toxic content of plant parts that are consumed in excessive amounts in such bundles, either accidentally or unknowingly. The health problems that can be caused by some plant species are listed in Table

Table 2. Contamination numbers and proportions of plant families with weed species in minor crop bundles in 2021-2023

Sampling year	2021-2022				2022-2023			
	Species		Total species contamination		Species		Total species contamination	
	Number	%	Number	%	Number	%	Number	%
Amaranthaceae	3	14.29	6	15.38	3	11.54	3	6.67
Apiaceae	1	4.76	2	5.13	1	3.85	1	2.22
Asteraceae	2	9.52	4	10.26	3	11.54	3	6.67
Boraginaceae	1	4.76	1	2.56	-		-	
Brassicaceae	-		-		1	3.85	1	2.22
Caryophyllaceae	1	4.76	1	2.56	-		-	
Convolvulaceae	1	4.76	2	5.13	1	3.85	7	15.56
Cyperaceae	1	4.76	8	20.51	1	3.85	3	6.67
Euphorbiaceae	1	4.76	1	2.56	1	3.85	1	2.22
Fabaceae	-		-		1	3.85	1	2.22
Malvaceae	-		-		2	7.69	2	4.44
Papaveraceae	1	4.76	1	2.56	1	3.85	3	6.67
Plantaginaceae	1	4.76	1	2.56	2	7.69	4	8.89
Poaceae	5	23.81	7	17.95	4	15.38	7	15.56
Polygonaceae	1	4.76	1	2.56	-		-	
Portulacaceae	1	4.76	3	7.69	1	3.85	2	4.44
Rubiaceae	-		-		1	3.85	1	2.22
Solanaceae	-		-		1	3.85	2	4.44
Urticaceae	1	4.76	1	2.56	1	3.85	3	6.67
Zygophyllaceae	-		-		1	3.85	1	2.22
Total	21	100.00	39	100.00	26	100.00	45	100.00

3. Due to the defence mechanisms of the plant's, touching some plants can cause some skin problems (*Euphorbia* spp., *Lolium* spp., *Urtica* spp. etc.), but ingestion can cause breathing problems, nausea, vomiting and diarrhoea (*Convolvulus* spp., *Polygonum* spp., *Solanum* spp. etc). If consumed unconsciously in excessive amounts, it can be life-threatening by affecting the functional processes of life. According to the National Poison Data System in California, USA, 27 cases of poisoning have been reported due to exposure to plant toxins such as oxalates, solanine and glycosides in 2021 (Gummin et al. 2022). Moreover, accidental ingestion by livestock can lead to physical and functional impairment and even death, compared to human poisoning in agricultural areas (Balabanlı et al. 2006, PoultryHelp 2023, Töngel and Ayan 2005).

Figure 1. Some plant parts detected in minor crop bundles

Periodic (seasonal and monthly) values were determined by examining the number of weed species found in minor crop bundles between 2021 and 2023. In this respect, the highest number of contaminations in the bundles was observed in spring-May (11 times), winter-December (9 times) and summer-July (8 times). The fact that winter weeds were in their developmental phase in November and December, and that summer species were introduced into the agroecosystem in spring instead of winter species, caused a high number of detections in the bundles. Depending on the climatic conditions in July, summer weed species can almost complete their development. For minor crops that can be produced throughout the year, the months of May 2021-2022 and December 2022-2023 were the periods with the highest number of bunches (Figure 2).

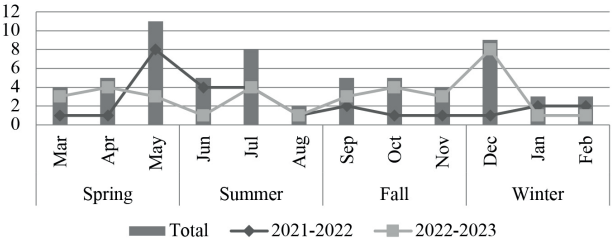

Figure 2. The number of weed species found in minor crop bundles during the sampling period

The weed species found in the field surveys of minor crops in Türkiye, the Aegean and the Mediterranean regions and those found in the bundles collected from the bazaar in the study showed similarities. *Amaranthus retroflexus* L., *Capsella bursa-pastoris* (L) Medik., *Chenopodium album* L., *Convolvulus arvensis* L., *Cyperus rotundus* L., *Echinochloa crus-galli* (L.) P.Beauv., *Portulaca oleracea* L., *Stellaria media* (L.) Vill. and *Urtica urens* L. were found in the minor crop field surveys between 2015 and 2016 (Table 4). Weed species such as *Amaranthus retroflexus* L. (2.96%), *Convolvulus arvensis* L. (6.67%), *Cyperus rotundus* L. (8.15%), *Fumaria officinalis* L. (2. 96%), *Portulaca oleracea* L. (3.70%), *Setaria viridis* (L.) P. Beauv (3.70%) and *Urtica urens* L. (2.96%) had the highest contamination rates in bundles (Table 3). The harmful components and toxin groups of some species whose plant parts were detected in the study are also listed in Table 4. Most of the species found in the bundles are thought to contain nitrate toxins. Species from Amaranthaceae, Malvaceae, Poaceae and Urticaceae families were the first to be found. Subsequently, species of Asteraceae and Boraginaceae families were found to contain pyrrolizidine alkaloids and species of the Apiaceae, Convolvulaceae and Papaveraceae families were found to contain alkaloids. In addition, *Stellaria media* (L.) Vill. contains glycoside toxin, *Euphorbia* spp. latex toxin, *Medicago orbicularis* (L.) Bartal. - mimosine toxin, *Polygonum lapathifolium* L. - saponin toxin and *Solanum nigrum* L. - solanine toxin (Table 4).

In the study conducted to determine the weed species, contamination ratios and contents in the minor crops consumed in Adana province, intensive contamination with plant parts and weed species of different families was found in the bundles. Weed toxins or harmful compounds in

Table 3. Weed species, EPPO codes and their contamination rates (%) in minor crop bundles in 2021-2023

Weed species	EPPO code	Lifecycle*	Possible edible parts**	Toxicity***	Contaminated ratios %		
					2021-2022	2022-2023	Average
Amaranthaceae							
Livid amaranth *Amaranthus blitum* L.	AMALI	A	L, S, St	-	-	1.33	0.74
Redroot pigweed *Amaranthus retroflexus* L.	AMARE	A	L, S, St	1	6.67	-	2.96
Slender amaranth *Amaranthus viridis* L.	AMAVI	A	L, S, St	1	1.67	1.33	1.48
Lambsquarters *Chenopodium album* L.	CHEAL	A	F, L, S, St	1	1.67	1.33	1.48
Apiaceae							
Chervil *Anthriscus cerefolium* (L.) Hoffm.	ANRCE	A	L, St	-	-	1.33	0.74
Queen Anne's lace, wild carrot *Daucus carota* L	DAUCA	B	F, St	1	3.33	-	1.48
Asteraceae							
Stinking hawksbeard *Crepis foetida* L.	CVPFO	A	L, St	-	-	1.33	0.74
Chamomile *Matricaria chamomilla* L.	MATCH	A	L, St	-	-	1.33	0.74
Eastern groundsel *Senecio vernalis* Waldst. & Kit.	SENVE	A	L, St	1, 2	1.67	1.33	1.48
Annual sowthistle *Sonchus oleraceus* L.	SONOL	A	L, St	1	5.00	-	2.22
Boraginaceae							
European heliotrope *Heliotropium europaeum* L.	HEOEU	A	L, St	2	1.67	-	0.74
Brassicaceae							
Shepherd's-purse *Capsella bursa-pastoris* (L.) Medik.	CAPBP	A	L, S, St	-	-	1.33	0.74
Caryophyllaceae							
Common chickweed *Stellaria media* (L.) Vill.	STEME	A	L, S, St	-	1.67	-	0.74
Convolvulaceae							
Field bindweed *Convolvulus arvensis* L.	CONAR	P	L, St	1, 2	3.33	9.33	6.67
Cyperaceae							
Purple nutsedge *Cyperus rotundus* L.	CYPRO	P	L, S	2	13.33	4.00	8.15
Euphorbiaceae							
Sun spurge *Euphorbia helioscopia* L.	EPHHE	A	L, St	1,2	1.67	-	0.74
Petty spurge *Euphorbia peplus* L.	EPHPE	A	L, St	1,2	-	1.33	0.74
Fabaceae							
Blackdisk medick *Medicago orbicularis* (L.) Bartal.	MEDOR	A	F, L, St	-	-	1.33	0.74
Malvaceae							
Venice mallow *Hibiscus trionum* L.	HIBTR	A	L, St	0	-	1.33	0.74
Common mallow *Malva neglecta* Wallr.	MALNE	A	L, S, St	-	-	1.33	0.74

Weed species	EPPO code	Lifecycle*	Possible edible parts**	Toxicity***	Contaminated ratios %		
					2021-2022	2022-2023	Average
Papaveraceae							
Drug fumitory *Fumaria officinalis* L.	FUMOF	A	L, St	-	1.67	4.00	2.96
Plantaginaceae							
Corn speedwell *Veronica arvensis* L.	VERAR	A	L, St	0	1.67	2.67	2.22
Ivyleaf speedwell *Veronica hederifolia* L.	VERHE	A	L, St	0	-	2.67	1.48
Poaceae							
Sterile oat *Avena sterilis* L.	AVEST	A	L, S	0	1.67	2.67	2.22
Cheatgrass, downy brome *Bromus tectorum* L.	BROTE	A	L, S	1	1.67	-	0.74
Barnyardgrass *Echinochloa crus-galli* (L.) P.Beauv.	ECHCG	A	L, S	1	1.67	-	0.74
Poison ryegrass *Lolium temulentum* L.	LOLTE	A	L, S	-	-	2.67	1.48
Annual bluegrass *Poa annua* L.	POAAN	A	L, S	0	-	1.33	0.74
Green foxtail *Setaria viridis* (L.) P.Beauv.	SETVI	A	L, S	-	5.00	2.67	3.70
Johnsongrass *Sorghum halepense* (L.) Pers.	SORHA	P	L, S	1	1.67	-	0.74
Polygonaceae							
Pale smartweed *Polygonum lapathifolium* L.	POLLA	A	L, S, St	1, 2	1.67	-	0.74
Portulacaceae							
Common purslane *Portulaca oleracea* L.	POROL	A	L, St	0	5.00	2.67	3.70
Rubiaceae							
Catchweed bedstraw *Galium aparine* L.	GALAP	A	L, St	-	-	1.33	0.74
Solanaceae							
Black nightshade *Solanum nigrum* L.	SOLNI	A	L, S, St	1, 2	-	2.67	1.48
Urticaceae							
Burning nettle *Urtica urens* L.	URTUR	A	L, St	1, 2	1.67	4.00	2.96
Zygophyllaceae							
Puncturevine *Tribulus terrestris* L.	TRBTE	A	L, St	-	-	1.33	0.74

* A: Annual weed, B: Biennial weed, P: Perennial weed.

** F: Flower, L: Leaf, S: Seed, St: Stem

*** (-)-Not known, (0)- No known risk, (1)-Minor; possible skin problems, breathing problems, nausea, vomiting and diarrhoea, (2)- Major; possible moderate illness and serious effects on the heart, liver, kidneys or brain (life threatening) (Also amended on Friday 2019, California Poison Control System 2023, PoultryHelp 2023).

Table 4. Determined minor crop survey fields of weeds and frequencies (%) in the Aegean and Mediterranean region, Türkiye (2015-2016) (Data frequencies are from Torun 2017, Sokat 2019)

Plant family	Toxins and compound group examples*	Weed species	Average weed frequency (%)
Amaranthaceae	flavonoid, nitrate, oxalate (Nitrates and nitrites, Oxalates, Phenolic compounds)	*Amaranthus retroflexus* L.	32.29
		Chenopodium album L.	33.49
Asteraceae	jacobine, jaconine, nitrate, oxalate, pyrrolizidine alkaloid, retrorsine, seneciphylline, silvasenesin, tropane, xanthostrumarin (Alkoloids, Glycosides, Nitrates and nitrites, Oxalates)	*Anthemis* spp.	13.54
		Capsella bursa-pastoris (L.) Medik.	22.34
		Conyza canadensis (L.) Cronquist	4.58
		Matricaria chamomilla L.	16.85
		Senecio vernalis Waldst. & Kit.	13.44
		Silybum marianum (L.) Gaertn.	17.19
		Sonchus spp.	18.13
		Xanthium strumarium L.	14.71
Boraginaceae	Heliotrine, indicine, nitrate, pyrrolizidine alkaloid, tropane (Alkoloids, Nitrates and nitrites)	*Heliotropium europaeum* L.	15.75
Brassicaceae	glucosinolate, isothiocyanate, sinalpin, sinigrin, thiocyanate (Glycosides)	*Sinapis arvensis* L.	16.76
Caryophyllaceae	nitrate, saponin (Glycosides, Nitrates and nitrites)	*Stellaria media* (L.) Vill.	29.77
Convolvulaceae	cuscohygrine,, indolizidine alkaloid, nortropane, pyrrolizidine alkaloid, tropine, tropinone (Alkoloids)	*Convolvulus arvensis* L.	21.65
Cyperaceae	hemolysin, plethora (Proteins)	*Cyperus rotundus* L.	44.41
Euphorbiaceae	cyanogenic glycoside, diterpenoid, euphorbin, nitrate, phorbol ester, resin, toxalbumin (Alkoloids, Glycosides, Nitrates and nitrites, Proteins, Resins-resinoids)	*Chrozophora tinctoria* (L.) A.Juss.	16.55
		Euphorbia spp.	9.87
Fabaceae	coumarin, cyanogenic glycoside, dicoumarol nicotinic alkaloid, pyrrolizidine alkaloid, toxalbumin (Alkoloids, Glycosides, Proteins)	*Melilotus indica* (L.) All.	7.09
Lamiaceae	pyrrolizidine alkaloid (Alkoloids)	*Lamium amplexicaule* L.	11.50
Malvaceae	Anthocyan, Flavonoid, Nitrate (Nitrates and nitrites, Phenolic compounds)	*Hibiscus trionum* L.	19.34
		Malva spp.	10.16
Orobanchaceae	glycoside, resin, tannin (Glycosides, Resins-resinoids, Tannins)	*Orabanche* spp.	2.09
Papaveraceae	coumarin, fumarine (Alkoloids)	*Fumaria officinalis* L.	6.08
Poaceae	cyanogenic glycoside, dhurrin, nitrate, prussic acid (Glycosides, Nitrates and nitrites)	*Avena* spp.	1.08
		Digitaria sanguinalis (L.) Scop.	1.08
		Echinochloa colonum (L.) Link	5.40
		Echinochloa crus-galli (L.) Beauv.	21.04
		Poa annua L.	19.42
		Setaria spp.	4.38
		Sorghum halepense (L.) Pers.	4.20
Polygonaceae	nitrate, oxalate (Nitrates and nitrites, Oxalates)	*Polygonum aviculare* L.	3.87
Portulacaceae	nitrate, oxalate (Nitrates and nitrites, Oxalates)	*Portulaca oleracea* L.	35.46
Primulaceae	cyclamine, oxalate, primin, saponin, tannin (Glycosides, Oxalates, Proteins, Tannins)	*Anagallis arvensis* L.	17.71
Solanaceae	chaconine, glyco alkaloid, nitrate, polyhydroxy alkaloid, soladulcidine, solanine, solasodine, steroidal alkaloid (Alkoloids, Nitrates and nitrites)	*Solanum nigrum* L.	19.04
Urticaceae	acetylcholine, nitrate, tannin, urticoside (Nitrates and nitrites, Proteins, Tannins)	*Urtica urens* L.	38.48
Zygophyllaceae	floeretrin pigment, nitrite, resin (Glycosides, Nitrates and nitrites, Resins-resinoids)	*Tribulus terrestris* L.	9.62

* Based on Cooper and Johnson 1984, Schultheiss et al. 1995, Institute of Medicine and National Research Council 2005, Töngel and Ayan 2005, Balabanlı et al. 2006, Öztürk et al. 2008, Van Der Merwe 2009, Diaz 2011, Simões et al. 2018, Al-Snafi 2020, Sokat 2021, Taheri et al. 2021, California Poison Control System 2023, CALS 2023, PoultryHelp 2023.

minor crops can cause significant loss of quality and change the taste of the bundles. In addition, weeds that have the potential to be poisonous when consumed can affect human health due to the toxins they contain.

A contamination rate of 50.37% of weed parts was found in 68 out of 135 bundles of minor crops purchased in the bazaar of Adana, Çukurova and Seyhan provinces. 36 different species were detected, with the highest contamination levels in rocket (54.54%) and parsley (52.94%) (Table 1). In the first year of sampling, plant parts of the families Amaranthaceae, Cyperaceae and Poaceae, and in the second year of sampling, plant parts of the species of the families Convolvulaceae and Poaceae showed the highest mixing percentages above 15% (Table 2 and Figure 1). As a result of the bundle purchases, *Cyperus rotundus* L. was found to be the species with the most mixed plant organs among the minor crop groups between 2021-2023, followed by *Convolvulus arvensis* L. and *Portulaca oleracea* L. species (Table 3). The species and families determined for the weed contamination ratio in the bundles were also similar to the species and families recorded in the surveys conducted in the Mediterranean and Aegean minor crop areas (Sokat 2019, Torun 2017). It was found that the leaf and stem parts of the plant species with the highest mixing were included in the bundles and that the plant parts could be consumed if the product bundles were not thoroughly cleaned. As a result of the study, it was found that the most consumed plant parts such as leaves and stems in bundles are between December and April (Figure 2). It has been shown that the environmental requirements for the development of some summer and winter weed species identified in the bundles, depending on the climate, are also within these periods, so that plant growth organs can easily mix into these bundles at harvest (Solak et al. 2015, TUBIVES 2023, Uygur et al. 1984, Üremiş and Uygur 1999).

On the other hand, such plants, which cause problems in agricultural areas in the country, can also be consumed consciously in rural areas (İyigün and Özer 2001, Üstüner 2022b, Yücel and Tunay 2002, Yücel et al. 2012). However, the toxins (harmful compounds) in these plants, which are unconsciously consumed in excessive amounts, can endanger human life (Gummin et al. 2022, Institute of Medicine and National Research Council 2005). Poisoning, i.e. health problems, can result from the toxins in these edible parts of the plant (Demir et al. 2006, Şimşek Yurt et al. 2019, Türkseven et al. 2021). This is because some plants that are poisonous or potentially poisonous may contain different amounts of toxins at different stages of development (Balabanlı et al. 2006, Chandra Sekhar et al. 2012, Öztürk et al. 2008, Sokat 2021, Töngel and Ayan 2005). For this reason, the amount of plant eaten is the poison ingested. It can become even more toxic when cooked.

The re-sowing of minor crop seeds contaminated with weed seeds leads to the spread of weeds. To achieve a high quality, economical and efficient product, the transport of weeds must be prevented by using clean and certified seed. Proper weed control at the edge of the field prevents weeds from leaving seeds for the next year. Contamination of fields with vegetative or reproductive organs of weeds by irrigation must be minimized by using sieves with different hole diameters. In short, there are effective methods of controlling weeds that affect the development of companion crops, such as cultural measures or crop rotation, and the use of a machine or hand hoe is an important option after sowing companion crops until harvest. In addition, fresh and continuous consumption of leaves and stems on the table prevents the use of herbicides, and therefore the use of registered herbicides for minor crops in agriculture is not allowed. For this reason, bundles taken from markets or bazaar in urban areas must be cleaned, and measures must be taken to ensure that they do not cause health problems. It is also important to be aware of the harmful compounds that are present when they are consumed. As with everything, it is the dose that makes the poison.

Author's Contributions

Authors declare the contribution of the authors is equal.

Statement of Conflict of Interest

The authors have declared no conflict of interest.

ÖZET

Yaprağı yenen sebzeler olan minör ürünler (maydanoz, nane, roka vb.) Türkiye'de sofraların vazgeçilmez tüketim ürünleri arasında yer almaktadır. Zengin ve besleyici içerikleri için yetiştirilen bu ürünler çiğ veya pişmiş olarak yenebilmektedir. Tarım alanlarında yabancı otlar, kontrol edilmediği takdirde minör ürünlerin gelişimini engellemekte, verimi ve ürün kalitesini düşürmektedir. Bu ürünlerle aynı zamanda yetişen yabancı otlar, hasat sırasında ürünlerle birlikte demetler halinde marketlere ulaşmakta ve marketlerden sofralara kadar gelmektedir. Yanlışlıkla demetlere karışan yabancı otların yoğun tüketimi zehirlenme gibi istenmeyen bazı sağlık sorunlarına neden olabilmektedir. Bu çalışmada, 2021-2023 yılları arasında Adana ilinde iki farklı ilçenin (Çukurova ve Seyhan) halk pazarından farklı dönemlerde periyodik olarak satın alınan minör ürün demetlerinin kontaminasyon oranları belirlenmiştir. İki yıl boyunca toplam 135 minör ürün demeti satın alınmış ve 36 farklı yabancı ot türü kaydedilmiştir. Toplam yabancı otların bulaşma oranının %50.37 olduğu ve en çok karışan türlerin *Cyperus rotundus* L. (%8.15), *Convolvulus arvensis*

L. (%6.67), *Portulaca oleracea* L. ve *Setaria viridis* (L.) P. Beauv (%3.70) olduğu tespit edilmiştir. Çalışmada, tüketilen demetlerin bitki parçaları ile kontaminasyon düzeyini ve bu demetlerde bulunan yabancı ot türlerinin sağlık üzerindeki toksisite potansiyelini (zararlı bileşenler ve toksinler ile ilgili daha önceki çalışmalara göre) belirlemek amacıyla gerçekleştirilmiştir.

Anahtar kelimeler: demet, zararlı bileşenler, sağlık, yapraklı sebzeler, bitkiler

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