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Traditional plant knowledge across rural and peri-urban Istanbul: documented plants and uses

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Abstract
Purpose: This study examines traditional plant knowledge in rural and peri-urban Istanbul, where environmental access, household production and metropolitan connections coexist.
Method: Fieldwork conducted in 30 neighbourhoods across ten districts in 2021–2022 involved 125 interviewees. Of these, 113 contributed information to the field-results database, and 112 reported at least one plant use included in the analytical dataset of 667 plant-use reports. Original descriptions were retained alongside standardized taxonomic and use fields. Analyses examined repertoire composition, citation frequency, multifunctionality and district overlap. Retrospective taxon-level classifications distinguished predominantly wild-gathered from cultivated, managed, planted or otherwise obtained taxa, and identified a conservative subset confirmed in Istanbul flora sources. District overlap was assessed using an informant-block permutation model; sampling-adequacy estimates were exploratory.
Findings: The repertoire comprises 174 taxa in 129 genera and 52 families, spanning 52 use categories, 25 plant-part groups and 12 preparation groups. Food accounted for 55.2% of reports, human health for 22.3% and household and material uses for 11.8%. Fruit and aerial parts predominated; cooking and raw use were the leading preparations. *Tilia tomentosa* led food citations, *Olea europaea* health and *Castanea sativa* household and material uses. The null model largely reproduced the raw increase in district overlap from taxa to preparations. Lower-than-expected preparation overlap did not survive multiple-testing correction. Reports involving predominantly wild-gathered taxa accounted for 52.9%; their share was higher in food than health, but taxon-level permutation did not support a systematic domain–acquisition association. Twenty-nine source-confirmed locally occurring or naturalized taxa were linked to 196 reports.
Conclusion: The food-weighted repertoire connects gathering and cultivation with household provisioning, seasonal processing and preservation. Wild-gathered and cultivated plants reflect varied forms of environmental access and household production. Spatial differences are described as locally configured combinations, without attribution to a single ecological, historical or migratory cause.
Keywords: urban ethnobiology, wild food, preparation techniques, household provisioning, local flora.

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İstanbul'un kırsal alanları ve kent çeperinde geleneksel bitki bilgisi: Kayıt altına alınan bitkiler ve kullanımları

Özet
Amaç: Bu çalışma, çevresel kaynaklara erişimin, hane üretiminin ve İstanbul'un kentsel sistemiyle kurulan bağlantıların bir arada bulunduğu kırsal alanlarda ve kent çeperindeki yerleşimlerde geleneksel bitki bilgisini incelemektedir.

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Yöntem: İstanbul'un on ilçesindeki 30 mahallede 2021–2022 yıllarında gerçekleştirilen saha çalışması kapsamında 125 kişiyle görüşülmüştür. Bunlardan 113'ü saha verileri veri tabanında yer alan bilgilere katkıda bulunmuş, 112'si ise 667 bitki-kullanım raporundan oluşan analitik veri setine dâhil edilen en az bir bitki kullanımı bildirmiştir. Kayıtlardaki özgün açıklamalar, standartlaştırılmış taksonomik ve kullanıma ilişkin veri alanlarıyla birlikte korunmuştur. Analizlerde derlenen bitki ve kullanım bilgilerinin bileşimi, atıf sıklığı, çok işlevlilik ve ilçeler arasındaki örtüşme incelenmiştir. Takson düzeyinde geriye dönük olarak yapılan sınıflandırmalarla, ağırlıklı olarak doğadan toplanan taksonlar ile yetiştirilen, bakımı yapılan, dikilen veya başka yollarla edinilen taksonlar birbirinden ayrılmış; ayrıca İstanbul florasına ilişkin kaynaklarda varlığı doğrulanan taksonlardan oluşan, temkinli biçimde sınırlandırılmış bir alt küme belirlenmiştir. İlçeler arasındaki örtüşme, her katılımcının bildirimlerini bir blok olarak koruyan permütasyon modeliyle değerlendirilmiş; örnekleme yeterliliğine ilişkin tahminler ise keşifsel amaçla kullanılmıştır.
Bulgular: Kayda geçen bitki bilgisi; 129 cinse ve 52 familyaya ait 174 taksonu, 52 kullanım kategorisini, 25 bitki kısmı grubunu ve 12 hazırlama biçimi grubunu kapsamaktadır. Raporların %55,2'sini gıda, %22,3'ünü insan sağlığı, %11,8'ini ise hane ve maddi kullanımlar oluşturmuştur. Meyve ve toprak üstü kısımlar en sık bildirilen bitki kısımları; pişirme ile çiğ veya işlem görmeden kullanım ise önde gelen hazırlama biçimleri olmuştur. Gıda alanındaki atıflarda *Tilia tomentosa*, sağlık alanında *Olea europaea*, hane ve maddi kullanımlarda ise *Castanea sativa* ilk sırada yer almıştır. Permütasyona dayalı sıfır model, ilçeler arasındaki örtüşmenin taksonlardan hazırlama biçimlerine doğru gösterdiği ham artışı büyük ölçüde yeniden üretmiştir. Hazırlama biçimlerindeki beklenenden düşük örtüşme, çoklu test düzeltmesinden sonra anlamlılığını korumamıştır. Ağırlıklı olarak doğadan toplanan taksonlara ilişkin raporlar, bütün raporların %52,9'unu oluşturmuştur. Bu raporların payı gıda alanında sağlık alanına göre daha yüksek olmakla birlikte, takson düzeyindeki permütasyon analizi kullanım alanı ile edinim biçimi arasında sistematik bir ilişki bulunduğunu desteklememiştir. İncelenen kaynaklarda İstanbul'da doğal olarak bulunduğu veya doğallaştığı doğrulanan 29 takson, 196 raporla ilişkilendirilmiştir.
Sonuç: Gıda ağırlıklı bu bilgi birikimi, doğadan toplama ve yetiştirme faaliyetlerini hane gereksinimlerinin karşılanması, mevsimsel işleme ve saklama uygulamalarıyla ilişkilendirmektedir. Doğadan toplanan ve yetiştirilen bitkiler, çevresel kaynaklara erişimin ve hane üretiminin farklı biçimlerini yansıtmaktadır. Mekânsal farklılıklar, tek bir ekolojik, tarihsel veya göçle ilişkili nedene bağlanmadan, yerel koşullarda biçimlenen bileşimler olarak ele alınmıştır.

Anahtar kelimeler: kentsel etnobiyoloji, yabani gıdalar, hazırlama teknikleri, hane gereksinimlerinin karşılanması, yerel flora.

1. Introduction

Ethnobotany combines biological documentation with the social study of knowledge. Plants are gathered, cultivated, exchanged, processed and used in food, health care and household work. Biocultural research treats biological and cultural diversity as interconnected [1], while traditional ecological knowledge research links observation, practice, social institutions and environmental setting [2, 3]. Plant-use records therefore concern where plants are obtained, which parts are used, how they are prepared and for what purposes. Urbanization may restrict gathering access and change plant-related occupations, while roads, markets, migration and household networks circulate plant materials and knowledge [4, 5, 6]. Traditional and biomedical knowledge may coexist in urban medicinal plant use [7].

Urban ethnobiology challenges the exclusively rural framing of plant knowledge: cities incorporate rural settlements, and migrants bring plant practices that may continue, change or combine with newly acquired knowledge. Gardens, forests and markets can remain important despite changing access and use [8, 9, 10]. Istanbul's administrative territory combines a densely built core with forests, coasts, watersheds, agricultural landscapes and the Princes' Islands. The sampled rural and peri-urban settlements lie largely outside the core, with differing access to forests, gardens, orchards and agricultural land despite metropolitan administrative, infrastructural and market connections.

Previous research documents plant knowledge in Silivri and Çatalca [11, 12, 13], wild food plants in Biga and medicinal and food plants on Marmara Island [14, 15]. This study extends the geographical perspective across rural and peri-urban Istanbul. The selected settlements are not representative of Istanbul as a whole, nor are their rural characteristics assumed unchanged. They allow plant knowledge to be examined where metropolitan incorporation coexists with continuing but unequal environmental access. The study asks which taxa, uses, parts and preparations occur in the records; which taxa recur across informants and domains; which can be conservatively linked to Istanbul's flora; how district overlap varies across analytical layers; and how complete documentation is within the realized sample.

2. Materials and methods

2.1. Study area

Fieldwork covered 30 neighbourhoods in ten districts over approximately 30 field days, considering Istanbul's forests, Black Sea and Marmara coasts, watersheds, agricultural land and islands. Most sites lay outside the densely built core, including forest villages, coastal and agricultural settlements, islands and formerly rural neighbourhoods

incorporated into the city. Sites differed in distance from the centre and environmental access; participants described farming, forestry, animal husbandry, fishing and gathering. Coverage ranged from several neighbourhoods per district to one locality. These purposively selected sites do not constitute a spatially balanced sample. Residents described long-established communities, population-exchange settlement and later migration from the Black Sea region and elsewhere. These histories provide context, not explanations of particular plant uses: individual reports cannot be reliably linked to Manav, muhacir, mübadil or later migrant identities. Detailed settlement descriptions are given in Additional file 10.

2.2. Study design and data collection

Fieldwork took place in 2021–2022 within Türkiye's national programme for documenting traditional knowledge associated with biological diversity, coordinated by the Ministry of Agriculture and Forestry through the General Directorate of Nature Conservation and National Parks. The programme documented plants, animals and fungi through fieldwork and literature review; this analysis includes only field-derived plant-use records. Participants were selected through purposive sampling, directly and through local referrals, for experience in farming, shepherding, animal husbandry, forestry, food preparation, handicrafts or household remedies. Semi-structured interviews with individuals sometimes developed into small-group conversations in village squares, coffeehouses and community spaces. Where possible, interviews continued during walks through plant-use environments. These were settings of the same qualitative approach, not separate mixed-method components. Group responses were not treated as independent verification.

Records include current practices and uses remembered from childhood, witnessed earlier or learned orally, including practices explicitly described as discontinued. Accounts identifying a plant and specific use were retained. A plant-use report therefore documents reported knowledge, not necessarily current, frequent or transmissible practice. Of 125 people interviewed, 113 contributed information to the field-results database and 112 contributed plant-use reports analysed here. The 113 participants were aged 29–90 years (mean 62.5); 90 were men (%79.6) and 23 women (%20.4). Demographic characteristics and migration histories were not consistently linked to individual reports, preventing attribution of taxa or practices to gender, origin or settlement identity. The predominance of men in the participant group is consistent with the recruitment process and interview settings: local referral chains and encounters in village squares, coffeehouses and other public spaces made men more readily accessible. This recruitment pattern may have influenced the forms of plant knowledge documented and should not be interpreted as representing the gender distribution of plant knowledge in the study communities.

2.3. Construction of the analytical database

Records varied in detail and structure, including plant names, uses, parts, preparations, administration routes, localities and participants. Plant records were separated from animal and fungal records and field-derived material from literature records. Of 1,999 project records, 811 were field results; excluding 59 fungal and 85 animal records yielded 667 plant-use reports. The analytical unit links one informant, one taxon and one specific use. Multiple uses reported by the same informant were entered separately. Informants could contribute several reports and taxa span several domains or preparations. Report frequencies describe repertoire composition, not independent observations or population prevalence.

Separate dictionaries standardized taxonomy, use domain and category, plant part, preparation and administration route while retaining local names and original descriptions. Uses formed nine domains and 52 categories; parts formed 25 groups. Preparations formed 12 mutually exclusive groups based on the principal recorded operation; administration route was separate. Unsupported assignments remained unspecified or unresolved. Crosswalks and coding rules are in the additional files. Taxonomic spelling, synonymy and accepted nomenclature were checked against Plants of the World Online [16]; names were not revised after the consultation date reported in the references. Twenty reports involving eight taxa remain under review. Programme vouchers are deposited in the Tekirdağ Namık Kemal University Herbarium (NAKU), with numbers recorded for all 174 taxa (Additional file 9). Vouchers are linked at taxon, not report level, documenting taxon identity rather than material behind individual reports. Quality control checked duplicates, missing identifiers, spelling variants and inconsistencies among use domains, parts, preparations and routes against source entries. Original and standardized fields were retained together, with versioned coding decisions supporting traceability.

2.4. Analytical variables and additional classifications

Use domains, parts and preparations were analysed as related dimensions of reported practice. Citation frequency and spatial recurrence described repeated taxa. Acquisition category and flora confirmation were separate: one concerns how taxa were generally obtained, the other their documented ecological occurrence. Frequency of citation (FC) counts distinct informants citing a taxon. Relative frequency was RFC = FC/N, with N = 112 plant-reporting informants. The programme's assessment used 113, including one participant without a plant-use report, so RFC here is marginally higher. Domain-specific RFC uses informants contributing to that domain as its denominator. Use-category breadth counts standardized categories per taxon; UR/FC is mean use reports per informant citing that taxon.

Each taxon was retrospectively classified as predominantly wild-gathered or cultivated, managed, planted or otherwise obtained, including purchased material. Classification concerned the predominant acquisition context documented during fieldwork rather than the taxon's botanical status in Istanbul. A taxon was assigned to the predominantly wild-gathered category when field accounts mainly referred to collection from uncultivated settings; the second category covered material associated principally with gardens, orchards or fields, planted or managed trees, or purchase. Where several acquisition routes occurred, the predominant context across the available field descriptions was used. Thus, a taxon confirmed in Istanbul's flora could still be classified as cultivated or managed in the study settlements. All 174 taxa were classified, including those under taxonomic review where evidence supported this broader assignment. Acquisition was not recorded per report, so the classification cannot identify whether individual material was gathered, grown, bought or otherwise acquired. Percentages refer to reports involving classified taxa, not observed gathering or cultivation frequencies.

The confirmed-local subset includes only taxa explicitly documented as naturally occurring or naturalized in at least one consulted Istanbul flora source [17]. Unconfirmed does not mean absent, exotic or non-local. Non-distributional treatments were not used to extend this subset; source-selection details are given in Additional file 10. The subset is an evidential minimum, not an estimate of the flora used. Further refinement requires province-wide flora and vegetation studies with explicit distributional criteria. Neighbourhoods and districts were also grouped into European mainland, Anatolian mainland and Princes' Islands sectors and four ecological landscape zones. Overlap among these, settlement histories and sampling intensity precludes treating them as independent causal variables.

2.5. Statistical analysis

Counts and percentages described reports, taxa, genera, families, domains, categories, parts and preparations. Unless stated otherwise, frequencies were report-based and separated by domain where pooling reflected domain size or definition. Presence–absence data yielded Jaccard similarity, $J(A,B) = |A \cap B|/|A \cup B|$, for all 45 district pairs at taxon, use-category, plant-part and preparation levels. Null distributions used 9,999 permutations of district labels across intact informant blocks, preserving informants' records and district sample sizes. Standardized effect sizes used null means and standard deviations; two-sided probabilities were adjusted across four layer tests by Benjamini–Hochberg. Observed mean overlaps received delete-one-informant jackknife intervals.

Wild-gathered shares were summarized overall and by domain, with 4,000 informant-bootstrap samples preserving each informant's reports. A separate test permuted acquisition labels across taxa 9,999 times, preserving each taxon's records. Sampling adequacy used incidence-based observed richness, Chao2, sample coverage [18] and Hill numbers q = 0, 1 and 2 [19], with informants as units. Under purposive sampling these diagnose documentary coverage, not population knowledge totals. Rarefaction details are given in Additional file 10. Analyses used Python 3, pandas, NumPy, SciPy, statsmodels 0.14.6 and pyethnobiology 0.1.1, with fixed random seeds; software citations are given in Additional file 10. Detailed dictionaries, model specifications and code are described in the additional files.

3. Results

3.1. Fieldwork coverage and composition of the analytical sample

Fieldwork yielded 667 plant-use reports from 112 informants across 30 neighbourhoods in ten districts. Neighbourhood and participant numbers were not preallocated; Table 1 describes coverage, not a balanced design.

Table 1. District coverage: neighbourhoods, informants, reports, taxa, confirmed-local report shares and distance from the city centre.

District	Nbhds	Informants	Reports	Taxa	Local reports (%)	Distance (km)
Şile	7	34	170	64	37.1	35–107
Çatalca	5	19	125	64	32.8	62–106
Beykoz	5	18	114	55	27.2	31–53
Silivri	3	7	77	43	29.9	94–104
Sarıyer	3	9	68	47	19.1	24–35
Adalar	2	7	26	20	19.2	27–36
Arnavutköy	1	3	26	22	26.9	46
Eyüpsultan	2	5	26	20	11.5	30–37
Çekmeköy	1	4	18	14	5.6	38
Pendik	1	6	17	13	52.9	32
Total	**30**	**112**	**667**	**174***	**29.4**	**24–107**

Taxon counts are not additive across districts; the total refers to the complete dataset.

The sampled neighbourhoods and their distances from Istanbul city centre were determined by the Republic of Türkiye Ministry of Agriculture and Forestry, General Directorate of Nature Conservation and National Parks (DKMP), 1st Regional Directorate, Istanbul Provincial Branch Directorate. "Local reports" denotes reports involving flora-confirmed naturally occurring or naturalized taxa; unconfirmed does not mean absent or non-local. Neighbourhood selection reasons and interview counts are in Additional file 1.

Sites lay 24–107 km from the centre (median 50 km); 11 exceeded 70 km. They included accessible settlements near the built area and more distant forest, coastal and agricultural localities. Şile contributed seven neighbourhoods and 170 reports, Çatalca five and 125; Çekmeköy and Pendik each contributed one neighbourhood and 18 and 17 reports, respectively (Table 1). District totals reflect access and referral networks, not population-level knowledge.

Pendik's relatively high confirmed-local share corresponds to nine of only 17 reports collected in a single neighbourhood. These nine reports involved seven confirmed taxa, with two reports each for *Malva sylvestris* L.and *Arbutus unedo* L. The percentage is therefore sensitive to the small district denominator and the taxonomic composition of the documented records; it should not be interpreted as evidence that locally occurring plants are generally used more frequently in Pendik.

3.2. Taxonomic composition

The 667 reports represented 174 taxa, 129 genera and 52 families. Rosaceae led report counts (104) and, with Lamiaceae, taxon richness (20 each); Lamiaceae contributed 36 reports. Malvaceae ranked second in reports (44 across four taxa), while Cornaceae and Urticaceae contributed 27 and 25 through one frequently cited taxon each (Additional file 6).

3.3. Use-domain composition

Table 2. Primary use domains represented among 667 plant-use reports

Primary use domain	**Plant-use reports (n)**	**Share (%)**
Food	368	55.2
Human health	149	22.3
Household and material uses	79	11.8
Environmental knowledge	22	3.3
Unresolved domain assignment	17	2.5
Veterinary	12	1.8
Agriculture	10	1.5
Ritual and belief	7	1.0
Fodder	3	0.4
Total	**667**	**100.0**

Percentages use all 667 reports; 17 unresolved reports remain included.

Food led with 368 reports (55.2%), followed by human health (149; 22.3%) and household and material uses (79; 11.8%), together 89.4% (Table 2; Figure 1). The 52 categories included cooked dishes (146 reports) and preserves (72) as leading food uses, and dermatological use (43) as leading health use. All 22 environmental-knowledge reports concerned bee or nectar resources. Seventeen unresolved reports were not redistributed. *Cornus mas* fruit entered preserves, drinks and soup; bark supplied dye and branches slings and walking sticks. *Castanea sativa* supplied food, baskets, handles, carts, construction and boat frames. These examples connect reported taxa with distinct household and craft activities. The unresolved reports originated from six source category–subcategory combinations whose labels either conflicted with the accompanying descriptions—for example, walking-stick manufacture recorded under health—or described practices crossing the standardized domains, particularly fishing-related uses. To avoid imposing an additional domain-level interpretation, these reports were retained in the denominator but were not reassigned.

The original five-category programme classification remains alongside the analytical classification. Differences reflect reassignment by reported use, including nectar plants to environmental knowledge. Full original totals and the crosswalk are in Additional file 8; a narrative explanation is given in Additional file 10. Food comprised 11 categories, health 14 and household and material uses 16. Cooked dishes and preserves contributed 59.2% of food reports; dermatological use and general symptomatic relief contributed 28.9% and 21.5% of health reports. Construction led material uses (29.1%); six material categories had one report each (Additional file 3).

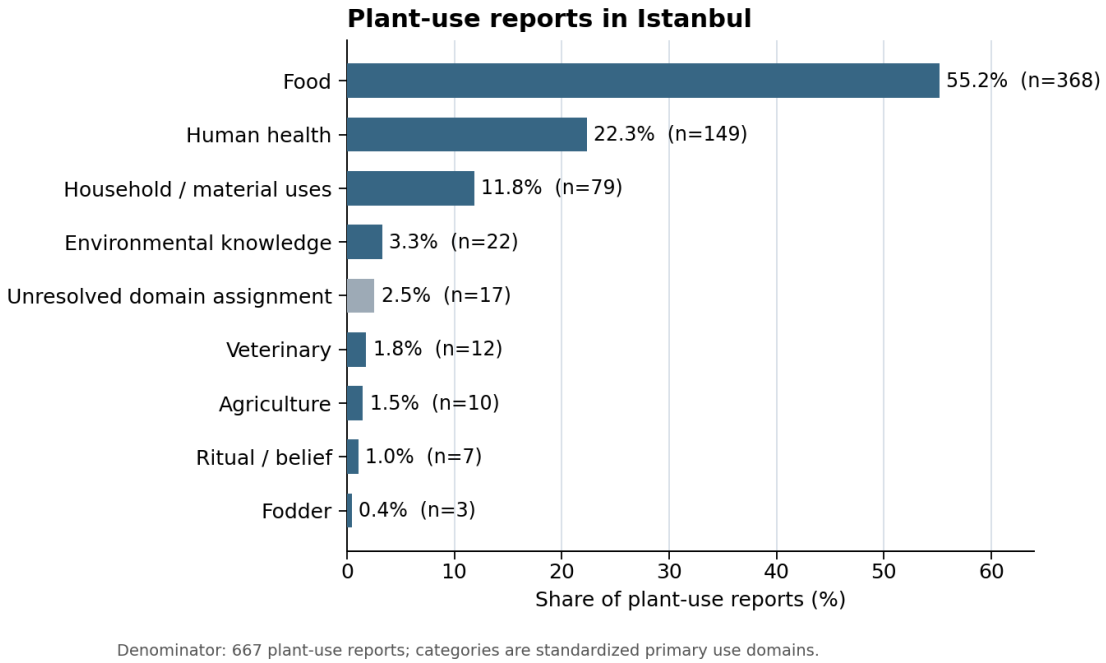

Figure 1. Primary use domains

3.4. Plant parts by use domain

Fruit (203 reports; 30.4%), aerial parts (181; 27.1%) and leaves (90; 13.5%) comprised 71.1% of reports; roots occurred in five (0.7%) (Additional file 4). Fruit contributed 34.2% of food and 33.6% of health reports; aerial parts and leaves together supplied 47.8% and 36.9%, respectively. In household and material uses, wood supplied 25.3%, stems 15.2% and fruit 7.6%. Wood was absent from food and appeared once in health, illustrating domain-specific part selection.

3.5. Preparation methods and administration route by use domain

Table 3. Preparation groups by domain, as counts and within-domain percentages

Preparation group	Food n (%)	Health n (%)	Household and material n (%)	Other domains n (%)	All reports
Cooking	165 (44.8)	2 (1.3)	0 (0.0)	1 (1.4)	168
Raw or no processing	36 (9.8)	58 (38.9)	27 (34.2)	45 (63.4)	166
Boiling or decoction	52 (14.1)	32 (21.5)	7 (8.9)	5 (7.0)	96
Other or unspecified	8 (2.2)	9 (6.0)	31 (39.2)	14 (19.7)	62
Infusion	27 (7.3)	12 (8.1)	0 (0.0)	0 (0.0)	39
Drying	17 (4.6)	2 (1.3)	10 (12.7)	2 (2.8)	31
Mixing or formulation	6 (1.6)	18 (12.1)	4 (5.1)	2 (2.8)	30
Blanching / boiling	23 (6.2)	5 (3.4)	0 (0.0)	0 (0.0)	28
Multiple methods	22 (6.0)	3 (2.0)	0 (0.0)	0 (0.0)	25
Fermentation	6 (1.6)	5 (3.4)	0 (0.0)	2 (2.8)	13
Roasting	6 (1.6)	0 (0.0)	0 (0.0)	0 (0.0)	6
Heating	0 (0.0)	3 (2.0)	0 (0.0)	0 (0.0)	3
Domain total	**368 (100.0)**	**149 (100.0)**	**79 (100.0)**	**71 (100.0)**	**667**

Groups are mutually exclusive. Other domains combines environmental knowledge, veterinary use, agriculture, ritual and belief, fodder and unresolved assignments.

Cooking (168 reports) and raw use (166) had similar pooled totals but different domain profiles (Table 3). Cooking accounted for 44.8% of food reports and only three outside food. Raw use led health (38.9%), household and material uses (34.2%) and other domains (63.4%), versus 9.8% in food. Food had the widest preparation range; roasting occurred only there. Boiling or decoction, infusion, blanching, multiple methods and drying followed cooking. Health

included more mixing or formulation (12.1% versus 1.6% in food); heating occurred only in health. Other or unspecified preparation led material uses (39.2%) (Table 3).

Original descriptions retain sequences obscured by categories. In Beykoz, *Smilax excelsa* leaves were boiled, drained and sautéed with onion, optionally adding yoghurt or egg. *Cornus mas* soup in Şile combined boiled fruit, flour-based umaç and fried onion. *Mespilus germanica* preservation varied by locality through vinegar, prior drying or salted water (Additional file 10).

A separate formulation field identified material mixtures in 136 reports (20.4%): food 23.6%, health 20.1%, material uses 15.2% and remaining domains 9.9%. This differs from the mutually exclusive "mixing or formulation" preparation group. Food was coded internal and material uses external, so pooled routes largely repeat domain definitions. Within health, 59.7% involved external and 40.3% internal administration, consistent with dermatological prominence. Routes are detailed in Additional file 5.

3.6. Salient taxa and multifunctionality

Tilia tomentosa led RFC (0.223; FC = 25), followed by *Cornus mas* (0.188) and *Urtica dioica* (0.170). *Cornus mas* generated more reports than *T. tomentosa* (27 versus 26), distinguishing reports from informant counts. *U. dioica* spanned eight districts, 18 neighbourhoods and 11 categories; Malva sylvestris spanned eight districts and 14 neighbourhoods (RFC 0.134). *Tilia tomentosa* combined tea with leaf sarma in Sarıyer and wood uses for tools, a darbuka and an ox cart. Such breadth joins dominant and rarer uses across parts and activities. *Tilia tomentosa* and Cornus mas predominantly involved cultivated or managed material. Citation frequency describes recurrence in informants' reports, not gathering or use frequency.

Table 4. Domain-stratified salience: most frequently cited taxa within each primary use domain

Food (n = 88 informants)	**FC (RFC_d)**	**Human health** (n = 65)	**FC (RFC_d)**	**Household and material** (n = 43)	**FC (RFC_d)**
Tilia tomentosa	21 (0.239)	*Olea europaea*	13 (0.200)	*Castanea sativa*	9 (0.209)
Cornus mas	16 (0.182)	*Allium cepa*	11 (0.169)	*Juglans regia*	8 (0.186)
Urtica dioica	15 (0.170)	*Momordica charantia*	10 (0.154)	*Pinus nigra*	5 (0.116)
Malva sylvestris	14 (0.159)	*Rubus sanctus*	6 (0.092)	*Quercus cerris*	5 (0.116)
Borago officinalis	13 (0.148)	*Vitis vinifera*	6 (0.092)	*Erica manipuliflora*	3 (0.070)
Rosa canina	13 (0.148)	*Urtica dioica*	5 (0.077)	*Lagenaria siceraria*	3 (0.070)
Chenopodium album	9 (0.102)	*Plantago major*	4 (0.062)	*Secale cereale*	3 (0.070)
Mespilus germanica	9 (0.102)	*Allium sativum*	3 (0.046)	*Carpinus betulus*	2 (0.047)
Prunus x domestica	9 (0.102)	*Brassica oleracea*	3 (0.046)	—	—
Pyrus elaeagnifolia	8 (0.091)	*Citrus limon*	3 (0.046)	—	—

FC counts distinct informants within each domain; RFC_d divides by domain informants (88, 65 and 43). These overlapping denominators differ from the pooled 112 in Table 5.

Table 5. Domain profile of the ten most frequently cited taxa overall

Taxon	**FC (all)**	**RFC**	**FC food**	**FC health**	**FC household and material**	**Domains**
Tilia tomentosa	25	0.223	21	2	2	4
Cornus mas	21	0.188	16	3	2	5
Urtica dioica	19	0.170	15	5	0	3
Allium cepa	15	0.134	4	11	0	3
Malva sylvestris	15	0.134	14	1	0	2
Borago officinalis	13	0.116	13	0	0	1
Castanea sativa	13	0.116	2	1	9	5
Juglans regia	13	0.116	1	2	8	6
Olea europaea	13	0.116	0	13	0	1
Rosa canina	13	0.116	13	1	0	2

Domain FC counts distinct informants citing that use; Domains counts primary use domains per taxon.

Equal pooled RFC can conceal different uses (Tables 4 and 5): all 13 *Olea europaea* informants reported health uses and none food, while all 13 *Rosa canina* informants reported food and one also health. *Castanea sativa* and Juglans regia were cited mainly for material uses; Allium cepa mainly for health. Domain rankings differed: *Tilia tomentosa* led

food, *Olea europaea* health and *Castanea sativa* material uses (Table 4). Only *Urtica dioica* appeared among the listed leading taxa in multiple domains. Table 5 gives pooled recurrence and domain profiles.

Most taxa (116; 66.7%) occurred in one domain; 40 occurred in two, 13 in three, two in four, two in five and one in six. *Juglans regia* spanned six, *Cornus mas* and *Castanea sativa* five, and *Tilia tomentosa* and *Allium sativum* four, crossing food, health and material or agricultural uses. Ninety-eight taxa occurred in one use category and 78 were reported once; 18 spanned at least five categories. *Urtica dioica* led category breadth (11), followed by Allium cepa, *Cornus mas* and *Castanea sativa* (10 each), and *Juglans regia* (nine). UR/FC ranged from 1.00 to 1.67 for taxa cited by at least five informants: multifunctionality accumulated across informants and settings rather than many uses per individual**.**

3.7. Layered consistency of the repertoire across districts

District overlap was assessed for taxa, use categories, plant parts and preparations. Their different vocabulary sizes require comparison with an informant-block null model rather than direct interpretation of raw differences.

Table 6. Observed and null-model mean pairwise Jaccard overlap among ten districts

Repertoire layer	Observed J	Null mean	SES	Permutation p	FDR q	95% CI
Plant taxa	0.151	0.169	−1.14	0.259	0.259	0.107–0.195
Fine-grained use categories	0.298	0.325	−1.14	0.249	0.259	0.219–0.377
Plant-part groups	0.401	0.451	−1.73	0.085	0.170	0.325–0.478
Preparation groups	0.562	0.648	−2.01	0.046	0.170	0.447–0.676

Means cover all district pairs; 95% CIs are delete-one-informant jackknife intervals. Null values use 9,999 district-label permutations across intact informant blocks. SES = standardized effect size; p is two-sided; FDR q adjusts four tests by Benjamini–Hochberg. Raw domain and confirmed-local overlaps appear in Additional file 10, Table S1. Absolute overlap depends on vocabulary size and saturation.

Raw mean overlap rose from taxa (0.151) through use categories (0.298) and parts (0.401) to preparations (0.562) (Table 6; Figure 2). The null model reproduced this gradient (0.169–0.648). Preparation overlap was lower than expected (SES = −2.01; p = 0.046), but no layer survived adjustment across four tests (q = 0.259, 0.259, 0.170 and 0.170). The unadjusted result is weak evidence, not support for a uniform technical repertoire or a graded spatial structure. Raw domain profiles differed: food use-category overlap (0.519) exceeded part (0.473) and preparation overlap (0.438), whereas health and material-use overlap rose from taxa to preparations. These vocabulary-dependent comparisons are descriptive (Additional file 10, Table S1).

Confirmed-local taxon overlap did not follow continental division: high values included Arnavutköy-Sarıyer (0.667), Arnavutköy-Pendik (0.556) and Beykoz-Çatalca (0.474), the latter two crossing the Bosphorus. Pair-specific and district-recurrence details are given in Additional file 10. Within the confirmed-local subset, taxon overlap rose to 0.254 and preparation overlap fell to 0.385. Their difference remained positive (0.132; 95% CI 0.004–0.260), but the subset's 196 reports warrant caution (Additional file 10, Table S1).

Predominantly wild-gathered taxa accounted for 353 reports (52.9%). Their share was highest in food (59.2%), followed by material uses (44.3%) and health (40.3%) (Table 7). The food–health gap was 19.0 percentage points (informant-bootstrap 95% CI 8.3–30.5), robust to informant resampling. This does not establish a domain–acquisition association: categories are taxon-level and frequently cited taxa dominate report totals. Randomly permuting labels across taxa yielded observed-or-larger chi-square values in 18.4% of 9,999 permutations (observed 18.16; null mean 11.24; p = 0.184). The contrast is therefore descriptive and compatible with chance category allocation across taxa.

The leading pooled taxa, *Tilia tomentosa* and Cornus mas, were cultivated or otherwise obtained. Wild-gathered citations were led by Urtica dioica, Malva sylvestris, Borago officinalis, Rosa canina, *Arbutus unedo* and Mespilus germanica. Aerial parts predominated more in wild-classified reports (41.6% versus 10.8%), while fruit was more prominent in cultivated-classified reports (35.4% versus 26.1%). Within food, cooking was more frequent for wild taxa (49.1% versus 38.7%), infusion for cultivated taxa (13.3% versus 3.2%). Unequal, sometimes small district samples preclude comparisons of district wild shares; detailed values are given in Additional file 10.

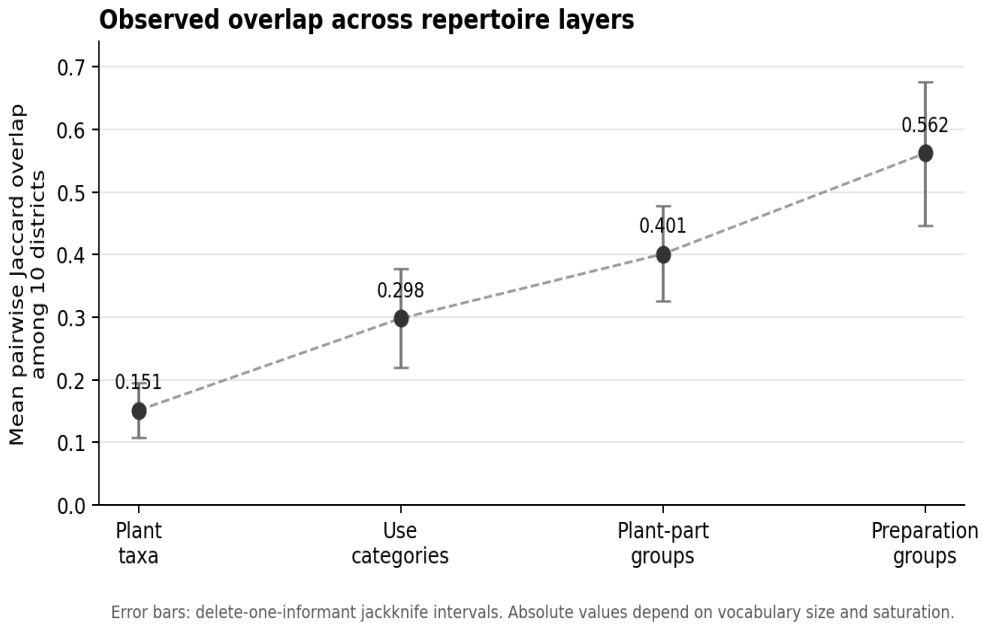

Figure 2. Raw mean district Jaccard overlap across four layers, with delete-one-informant jackknife intervals. Vocabulary size and saturation affect the ordering; Table 6 provides the inferential compariso

3.8. Acquisition category of the taxa used

Table 7. Reports by taxon-level acquisition category and use domain.

Primary use domain	Wild	Cultivated	Wild %	95% CI
Food	218	150	59.2	52.1–66.6
Human health	60	89	40.3	31.7–48.7
Household and material uses	35	44	44.3	32.9–58.3
Other domains	40	31	56.3	46.5–67.2
All reports	353	314	52.9	—

Wild = predominantly wild-gathered taxa; Cultivated = cultivated, managed, planted or otherwise obtained taxa. Other domains are as in Table 3. Intervals resample intact informant records (4,000 replicates). Reports are dependent and acquisition is taxon-level; ordinary Pearson chi-square inference is invalid. Inference uses the taxon-label permutation test in the text.

3.9. The confirmed-local subset

The conservative flora match confirmed 29 taxa (16.7%) associated with 196 reports (29.4%). Food contributed 57.1%, material uses 15.3%, health 11.7% and environmental knowledge 6.6%. These are minimum source-confirmed values; unconfirmed does not mean absent, exotic or cultivated (Additional file 10, Table S2). *Cornus mas* and *Malva sylvestris* were recorded in eight districts, *Arbutus unedo* and *Tilia tomentosa* in seven, and *Rosa canina* in six. Other taxa had district-specific recorded uses, without implying ecological restriction to those districts; the full list is given in Additional file 10.

Food shares were similar in confirmed and unconfirmed reports, but health was lower in confirmed reports (11.7% versus 26.8%), while material, environmental and veterinary shares were higher. This concerns verification status, not medicinal plants' absence, exotic origin or acquisition outside Istanbul (Additional file 10, Table S3). Infusion was more frequent in confirmed-local reports (13.3% versus 2.8%), cooking less frequent (18.9% versus 27.8%). Within food, infusion was 18.8% versus 2.3%, largely driven by *Tilia tomentosa*, flora-confirmed but classified as cultivated or otherwise obtained. Acquisition-based comparison reverses the direction: cultivated food infusion was 13.3% versus 3.2% for wild taxa. Fruit and wood were over-represented in confirmed reports, leaves under-represented (Additional file 10, Table S3).

Flora confirmation and taxon-level acquisition classification answer different questions; neither identifies how material in an individual report was obtained. Şile and Çatalca each recorded 16 confirmed-local taxa, but Şile's uses spanned more domains. Food contributed 42.9% of Şile's 63 confirmed-local reports versus 70.7% of Çatalca's 41. The contrast concerns domain breadth, not greater confirmed-local taxon richness (Additional file 10).

3.10. Spatial description

European and Anatolian mainland sectors contributed similar report totals (322 and 319) from unequal informant numbers (43 and 62). Food predominated more in European reports (62.4%); health (26.6%) and material uses (14.4%) were more prominent in Anatolian reports. These profiles are descriptive (Additional file 10, Table S4). The Black Sea coast and northern forest belt contributed almost half of reports and the largest taxon list. Sector, landscape, district, settlement history and sampling intensity overlap; these contrasts receive no causal interpretation. Documented Balkan/Rumeli migration settlements were on the European mainland; seven of eight settlements coded as long-settled Manav villages were in Şile. Islands coverage comprised only two neighbourhoods, and district effort varied tenfold. The design cannot separate ecological, historical and sampling contributions, so district richness is not ranked.

3.11. Sampling adequacy

Overall sample coverage was 0.848; exploratory Chao2 richness was 316 taxa against 174 observed (Additional file 7). Purposive selection and sensitivity to rare taxa limit interpretation to realized-sample saturation, not the repertoire's true completeness. Mainland coverage estimates were similar (0.799 and 0.806). At 43 informants, incidence-based rarefaction retained 114 European taxa and reduced Anatolian richness from 101 to 83.3; informant count alone therefore does not explain the observed difference. Islands coverage was 0.470; district coverage ranged from 0.171 to 0.764, precluding district richness comparison. Seventy-eight taxa reported once further indicate incomplete saturation. Calculation details are given in Additional file 10.

Food coverage was highest (0.832; 104 observed taxa; Chao2 219), followed by material uses (0.743 from 79 reports). Health coverage was 0.664, with 46 of 68 taxa cited by one informant and Chao2 172. Health was therefore less completely documented within this sample, not necessarily less socially important.

4. Discussion

4.1. Spatial differentiation across analytical layers

The raw overlap gradient largely reappeared under randomized district allocation, showing how small vocabularies saturate rapidly. Lower-than-expected preparation overlap did not survive multiple-testing correction. Districts may combine recurrent operations with different plants, parts and purposes; the results do not demonstrate spatially uniform techniques. Food shares and preparations varied, but ecological access, household histories, markets and fieldwork coverage remain intertwined. Claims about recipe circulation or embodied techniques require interviews linking procedures with learning histories and material sources.

4.2. Food, household provisioning and seasonal economy

Food's prominence places plant knowledge within gathering, cultivation, selection, preparation and preservation, rather than treating edible plants as residual to medicine. Seasonal judgement and household labour can supplement purchases and extend harvested or gathered supplies. *Cornus mas* and *Mespilus germanica* preparations illustrate how boiling, sweetening, drying, pickling and bottling convert seasonal fruit into immediate foods and stored provisions. Food knowledge was prominent despite predominantly male participation. Men may have described their own gathering or cooking experience or practices of other household members. Without sex-linked reports, the data cannot distinguish these possibilities or map culinary skills by gender.

Studies in Biga and Marmara Island likewise document wild food practices [14, 15]. Migration and urban ethnobotany research highlights retention and recombination through networks [5, 6, 7]. Intergenerational studies link learning to family practice, continuing use and mobility [20, 21, 22]. The Istanbul profile similarly directs attention to provisioning alongside therapeutic knowledge.

4.3. Plant parts, preparation and material practice

Pooled preparation frequencies conceal domain-specific operations: cooking belongs mainly to food, raw use leads elsewhere, and wood and stems concentrate in material work. These distinctions connect botanical selection with purposes and techniques. Cooking and blanching involve judgements of edibility, taste, texture and unwanted qualities; drying and fermentation extend availability. These records do not measure consumption frequency, portions or nutrition. Preparation sequences connect identification with learned judgements about timing, heat, concentration and durability, as well as tools and sensory experience. Original descriptions preserve practical specificity that standardized groups cannot fully convey. Administration route is informative within health, where internal and external uses distinguish forms of care; pooled route totals mainly restate domain definitions.

4.4. Recurrence and forms of plant prominence

Domain-specific RFC distinguishes recurrence in food, health and material work. Taxa with identical pooled salience, such as *Olea europaea* and *Rosa canina*, can occupy different domains. Citation frequency, category breadth and spatial recurrence describe different forms of prominence. Field descriptions connect them to specific purposes and settings; frequency alone is not cultural significance [23]. Family rankings likewise combine taxonomic breadth and repeated citation of individual species. Comparison with regional studies requires harmonized sampling, definitions and taxonomy.

4.5. Gathering, cultivation and access

Wild-classified taxa accounted for slightly over half of reports, but leading cultivated taxa show that recurrence also concerns gardens, orchards, planted trees and purchased material. Wild and cultivated mark positions within an access-and-management continuum: plants may be tolerated, protected, transplanted, tended, exchanged or purchased. These practices connect knowledge with care, production and markets. Taxon-level categories cannot recover each report's acquisition circumstances or represent multiple routes simultaneously. Chestnut and linden connect managed woodland and settlement trees with food, crafts and construction. Access therefore involves more than collecting, and different materials entail different labour and uses. Contrasts in aerial parts, fruit, cooking and infusion suggest that gathering and cultivation contribute differently handled materials as well as different taxa.

4.6. Locally occurring plants in the documented repertoire

The confirmed-local subset links documented ecological occurrence to diverse uses, but is an evidential minimum, not a measure of Istanbul's flora used by residents. Şile and Çatalca had equal confirmed taxon counts but different use-domain breadth. Ecological occurrence does not determine use; local needs, skills and access also matter.

4.7. Istanbul's rural and peri-urban areas

The sites are metropolitan settlements with continuing but unequal environmental access. Their rural characteristics persist amid changing mobility, land use and livelihoods, rather than as intact survivals. Urban incorporation can coexist with gardening, cultivation and gathering while altering their environmental and social conditions [9]. The repertoire belongs within this changing metropolitan context.

4.8. Settlement histories and changing plant knowledge

Settlement histories caution against attributing this knowledge to one continuously resident population. Long-established communities, displaced groups and later migrants may retain or adapt practices through family and social networks [5, 6, 10]. Yet individual reports lack migration histories: mobility and local continuity remain interpretive contexts, not explanations of particular uses or district differences. Current, remembered and orally transmitted practices coexist in the records. Without consistent temporal coding, the database cannot establish continuity, decline or future transmission, nor distinguish all ongoing practices from knowledge retained through memory.

4.9. Database construction and traceability

Standardization involves curatorial decisions. Retaining local names and original descriptions beside analytical values makes these decisions and unresolved cases traceable. Participant, report and category remain distinct, preventing report counts from becoming respondent prevalence. Temporal status was not inferred where original descriptions were ambiguous.

4.10. Limitations

Purposive and referral-based selection, uneven district effort and unflagged group conversations limit representativeness and independence. Findings describe selected locality and participant networks, not knowledge distribution across Istanbul. Male predominance and interviews in public settings may shape documented knowledge. Incomplete links between participant characteristics and reports preclude comparisons by gender, age or occupation.

The cross-sectional design includes current and remembered knowledge but cannot establish historical continuity, decline or urbanisation's causal effects. Overlap among district, sector, landscape and settlement history prevents estimating their independent effects; spatial differences remain descriptive. Twenty reports involving eight taxa remain under review; the two corrected identifications indicate residual taxonomic uncertainty. Source-limited flora

confirmation cannot establish non-locality. Taxon-level vouchers cannot trace individual reports to specimens, and taxon-level acquisition cannot distinguish the same species gathered in one locality and cultivated elsewhere.

5. Conclusions

Across 30 rural and peri-urban neighbourhoods, 667 reports concerning 174 taxa document plant knowledge centred on food, with distinct health and material repertoires. Gathering, cultivation, seasonal preparation and preservation connect this knowledge with household provisioning. Lower health coverage describes documentation conditions, not social value or historical decline. Selective sharing, concentration among particular people or families, or interview circumstances may contribute.

District differences concern combinations of plants, parts and techniques. High raw preparation overlap does not demonstrate uniform tradition, while wild-gathered, cultivated, managed and purchased materials reflect several forms of environmental access. Metropolitan incorporation has not made forests, gardens, orchards and agricultural land irrelevant to local plant practices. Their changing links with mobility, markets and land use warrant further qualitative and historical investigation. This study provides a traceable descriptive basis for that work.

Abbreviations: BGB: traditional knowledge based on biological diversity (Biyolojik Çeşitliliğe Dayalı Geleneksel Bilgi); CI: confidence interval; FC: frequency of citation; FDR: false discovery rate; NAKU: Tekirdağ Namık Kemal University Herbarium; RFC: relative frequency of citation; SES: standardized effect size; UR: use reports.

Artificial Intelligence Statement

During this study, the authors used ChatGPT (OpenAI) to assist in standardizing use categories and data fields while constructing the analytical database from the original field records. Claude (Anthropic) was used for English-language editing and to suggest condensation of the manuscript text. All AI-assisted outputs were reviewed, checked against the original records and edited by the authors, who take full responsibility for the data, methods and content of the manuscript.

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Author contributions: EA: conception, design, supervision, providing, data collection, analysis and interpretation, literature review, writing and critical review; REA: design, data collection and processing (analytical database), analysis and interpretation, literature review, writing and critical review; AKD: data collection, literature review and critical review; OD: data processing, statistical analysis and interpretation, and critical review; EC: supervision (field team leader), materials (taxonomic identification and vouchers), data collection and critical review. All authors read and approved the final manuscript.

Ethical statement: Ethics committee approval was not obtained, because the interviews were not conducted as an independent academic study but within an official project commissioned by the Republic of Türkiye Ministry of Agriculture and Forestry (tender registration no. 2021/100857). In each locality, the neighbourhood headman was contacted first, and technical staff of the DKMP Istanbul Provincial Branch Directorate took part in the field visits. Participants were informed of the official purpose of the project and took part voluntarily; audio, photographic and video recordings were made and plant material was collected with their permission. The present article analyses the anonymized project records; no names or other personal identifying information of participants are published, and the data are reported in aggregate.

Data Availability Statement: The versioned Istanbul Traditional Plant Knowledge Database retains original variables alongside traceable standardized fields. Additional files 1–9 describe sampling, quality control, use categories, parts, administration routes, families, sampling adequacy, classification crosswalks and the 174-taxon inventory with NAKU vouchers. Additional file 10 provides supplementary Tables S1–S4 and supporting descriptions.

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