



Mechanisms and motivations of medicinal plant use against dysmenorrhea

Berber E. Zandstra, Tinde R. van Anandel and Isabela Pombo Geertsma

Correspondence

Berber E. Zandstra¹, Tinde R. van Anandel^{1,2} and Isabela Pombo Geertsma^{2,3}

¹Biosystematics Group, Wageningen University & Research, Droevendaalsesteeg 1, 6708 PB Wageningen, the Netherlands.

²Naturalis Biodiversity Center, Darwinweg 2, 2333 CR Leiden, the Netherlands.

³Quantitative Biodiversity Dynamics, Utrecht University Botanic Gardens, Budapestlaan 17, 3584 CD Utrecht, the Netherlands.

*Corresponding Author: berber.zandstra@wur.nl

Ethnobotany Research and Applications 29:68 (2024) - <http://dx.doi.org/10.32859/era.29.68.1-24>

Manuscript received: 02/12/2024 – Revised manuscript received: 09/12/2024 - Published: 09/12/2024

Research

Abstract

Background: Dysmenorrhea (painful menstruation) negatively impacts the lives of many women on a global scale. For centuries, women across the world have relied on medicinal plants to treat dysmenorrhea. For an industrialized country like the Netherlands, however, data on such plant use is almost absent. This study aimed to document which plant taxa women in the Netherlands use to treat dysmenorrhea and their motivations behind plant choice.

Methods: Semi-structured interviews and online surveys were conducted among women who used and advised plants to treat dysmenorrhea. Respondents were recruited via social media and snowballing. Literature research was conducted to investigate what phytochemicals are related to alleviating dysmenorrhea in the Netherlands and abroad.

Results: Our 156 respondents mentioned 87 plant taxa to treat menstrual pain. *Alchemilla* spp., *Achillea millefolium* L., *Matricaria* spp., *Rubus idaeus* L., *Salix* spp., *Cannabis sativa* L. and *Zingiber officinale* Roscoe were the most used and advised plant taxa. Familiarity, experienced positive effects and availability were the most important motivations reported for choosing specific plant taxa. Experienced side effects as a result of painkillers were often mentioned as a reason to use herbal medicine.

Conclusions: This study is a valuable addition to current knowledge about medicinal plant use to alleviate dysmenorrhea. The reported plant taxa were similarly used in other countries and contained a wide variety of mechanisms of action, which indicates that dysmenorrhea can have different treatments. Gaining more insight in women's healthcare choices and motivations is vital in securing high-quality and suitable, personalized healthcare.

Keywords: Ethnobotany; The Netherlands; Gynecology; Herbal medicine; Phytochemicals; Painful menstruation; Alternative healthcare; Availability hypothesis; Migration botany

Samenvatting (Dutch abstract)

Achtergrond: Menstruatiepijn heeft een negatieve invloed op de levens van vele vrouwen wereldwijd. Vrouwen uit alle culturen hebben eeuwenlang vertrouwd op medicinale planten om menstruatiepijn te bestrijden. Data over dit soort plantengebruik is echter bijna afwezig voor een geïndustrialiseerd land als Nederland. Dit onderzoek richtte zich op het documenteren van plantentaxa die vrouwen in Nederland gebruiken om menstruatiepijn te behandelen en hun beweegredenen achter plantenkeuzes.

Methoden: Semigestructureerde interviews en online enquêtes werden afgenomen onder vrouwen die medicinale planten gebruikten en adviseerden om menstruatiepijn te behandelen. Respondenten werden geworven via social media en de sneeuwbal methode. Literatuuronderzoek werd uitgevoerd om uit te zoeken welke inhoudsstoffen uit de genoemde plantensoorten gerelateerd zijn aan het bestrijden van menstruatiepijn in Nederland en het buitenland.

Resultaten: Onze 156 respondenten noemden 87 plantentaxa om menstruatiepijn te behandelen. *Alchemilla* spp., *Achillea millefolium* L., *Matricaria* spp., *Rubus idaeus* L., *Salix* spp., *Cannabis sativa* L. en *Zingiber officinale* Roscoe waren de meest gebruikte en geadviseerde plantentaxa. Bekendheid, ervaringen met positieve effecten en toegankelijkheid waren de meest belangrijke beweegredenen om voor bepaalde plantentaxa te kiezen. Bijwerkingen bij het gebruik van pijnstillers werden vaak genoemd als reden om kruidenmiddelen te gebruiken.

Conclusies: Dit onderzoek is een waardevolle toevoeging aan de huidige kennis over medicinaal plantengebruik om menstruatiepijn te verlichten. De genoemde plantentaxa werden op vergelijkbare manier gebruikt in andere landen en bevatten een grote variatie aan werkingsmechanismen, wat aangeeft dat menstruatiepijn verschillende behandelingen kan hebben. Het is cruciaal om meer kennis te vergaren over de zorgkeuzes van vrouwen, zodat ook zij passende en hoogwaardige gezondheidszorg aangeboden krijgen.

Background

Dysmenorrhea or painful menstruation is a common gynecological condition among menstruating women, especially among adolescents (Hadjou *et al.* 2022, Mariappen *et al.* 2022, Shetty *et al.* 2018, Xu *et al.* 2020). Symptoms include lower abdominal pain, nausea, vomiting, backaches, weakness, sleeplessness and depression (Harel 2008). Multiple studies have demonstrated that dysmenorrhea symptoms impact women's lives in a negative way: they are a major cause of absenteeism in work or school, decreased classroom performance in adolescents, and affect overall quality of life (Armour *et al.* 2019, Iacovides *et al.* 2015, Unsal *et al.* 2010, Zannoni *et al.* 2014).

In the Netherlands, women also face these challenges during their menstruation. In a survey among 42879 Dutch women, 85.4% experienced dysmenorrhea and 38.4% were limited in their daily activities because of their menstrual period (Schoep *et al.* 2019). Dutch official medical websites often advise heat packs, rest, physical exercise and a healthy lifestyle as non-pharmaceutical ways to treat dysmenorrhea (Gyn&Co & Mawet 2016, KNMP 2021, Thuisarts.nl 2022). In addition, a number of medical treatments are advised, such as paracetamol, non-steroidal anti-inflammatory drugs (NSAIDs) and contraception. (Gyn&Co & Mawet 2016, KNMP 2021, Thuisarts.nl 2022). Women in the Netherlands use these medical treatments often: in a previous study 59.4% reported on using paracetamol, 62.2% used NSAIDs and 51.4% used contraception (Schoep *et al.* 2019).

Worldwide, women often rely on medicinal plants: over 2000 plant taxa are used for female reproductive health in the America's, the Caribbean, Europe, sub-Saharan Africa, Oceania and Asia, of which most were used to treat dysmenorrhea, regulate menstruation cycles or to induce abortion (Jiao *et al.* 2022, Moerman 1977, Van Andel *et al.* 2014, Vandebroek *et al.* 2007). Van Andel *et al.* (2014) showed that *Citrus*, *Senna*, *Phyllanthus* and *Gossypium* spp. were most widely used across the world. Moerman (1977) and Vandebroek *et al.* (2007) reported species such as *Artemisia biennis* Willd., *Asarum canadense* L., *Matricaria chamomilla* L. and *Illicium verum* Hook.f., which were used by indigenous peoples and Dominican immigrants in North America. Lastly, in a review of plants used for female health in 16 countries, excluding the Netherlands, 217 taxa were used to treat dysmenorrhea, of which four were used in more than two countries: *Artemisia vulgaris* L., *Achyranthes aspera* L., *Matricaria chamomilla* and *Foeniculum vulgare* Mill., although the parts used and preparations differed (Jiao *et al.* 2022).

Although dysmenorrhea significantly impacts Dutch women as well, little is known about how people treat this with herbal remedies. An exception is a broader study on medicinal plant use among Surinamese migrants in the Netherlands, which

found that *Gossypium barbadense* L. and *Aristolochia consimilis* Mast. were most cited for gynecological problems (Van Aniel & Westers, 2010). One of the most popular traditional herbal treatments was a vaginal steam bath with *G. barbadense*, which Surinamese women took to cleanse their uterus after childbirth or menstruation. Bitter tonics containing diverse plant material were also ingested to treat painful menstruations (Van Aniel & Westers, 2010). Beyond this research, there is no systematic study on plants used to treat dysmenorrhea among the rest of the female population in the Netherlands.

Yet, Dutch herbals, excluding Surinamese and Dutch Caribbean literature, advise plants such as *Achillea millefolium* L., *Matricaria recutita* L., *Viburnum opulus* L. and *Artemisia vulgaris* to alleviate dysmenorrhea symptoms (Hilgers 2021, Verhelst 2022). These species are commonly found in natural and disturbed habitats in the Netherlands (Duistermaat 2020, NDFF Verspreidingsatlas 2020). Although these herbs seem easily available, it remains unknown whether women in the Netherlands actually use these plants to treat dysmenorrhea.

Therefore, this study aims to provide insight in the plant taxa women in the Netherlands use to treat dysmenorrhea and why. We wanted to reveal the reasons why women use plants instead of or in addition to using conventional drugs (such as paracetamol or NSAIDs). Lastly, we reviewed the phytochemical properties of frequently mentioned plant taxa in this study and their use to treat dysmenorrhea in other countries. We formulated the following research questions:

1. Which plant taxa do women use to alleviate dysmenorrhea symptoms in the Netherlands?
2. Why do they use these specific taxa?
3. Why do they use medicinal plants instead of or in addition to synthetic painkillers?
4. What are phytochemical properties related to treating dysmenorrhea of frequently mentioned plant taxa in the Netherlands and abroad?

We hypothesized that women chose plant species according to the availability hypothesis postulated by Albuquerque (2006) and Voeks (2004), which states that people more often use plant species that are familiar, native, accessible throughout the year, easy to collect and/or cheaper in price (Albuquerque 2006, Gaoue *et al.* 2017, Gavin 2009). We expected that women in this study would use taxa that are readily available in Dutch supermarkets, (online) herbal shops, gardens and nature, as these products or plant material would be most familiar to them.

Furthermore, we expected that women used plants instead of conventional drugs because they felt herbs worked better than drugs, caused fewer side effects, they grew up with using plants as medicine and/or they did not trust modern medicine. These were all common reasons people gave for preferring herbal remedies instead of synthetic drugs elsewhere (Sawalha *et al.* 2008, Sinclair *et al.* 2022, Van Aniel & Westers 2010).

Materials and Methods

Study area

The Netherlands is a highly industrialized and urbanized country with 18 million inhabitants, of which 74% live in an urban environment (CBS 2024, Nabielek & Hamers 2015). In 2015, 67% of the total area of the Netherlands (4.2 million hectares) was used for agriculture and buildings, while only 12% consisted of nature areas and reserves (CBS 2020). Still, people have readily access to green environments: the distance from home to public green spaces (such as parks, forests and playgrounds) is 500 meters on average (CBS 2020). Other accessible green spaces include home gardens, of which there are 5.4 million in the Netherlands. Since there are 8.1 million households in the Netherlands, approximately two-thirds of the households owns a garden (CBS 2023). Ecosystems in the Netherlands are under high pressure (De Jong *et al.* 2022). In 2018, over 71% of Dutch nature areas were seriously threatened due to high nitrogen emissions (CBS 2021, De Jong *et al.* 2022). Plant gathering from nature is officially prohibited, although gathering for own consumption is tolerated in some natural areas (Natuurmonumenten n.d., Overheid.nl 2023, Staatsbosbeheer 2023). No official data exist on the number of people gathering wild plants in the Netherlands or on the species and volumes collected.

Participant recruitment

Semi-structured interviews and online surveys with open ended and closed questions were conducted among women in the Netherlands, whether they used medicinal plants to treat dysmenorrhea and people who self-identified as knowledgeable about the use of such plants. We found respondents by searching on Google, Facebook and Instagram, posting messages in Facebook groups dedicated to medicinal plants, and by snowball sampling (Albuquerque *et al.* 2014, Martin 1995). There are multiple Dutch Facebook groups dedicated to medicinal plant use, including groups geared towards people with a migration background (Appendix A), on which we posted messages including an interview request and a link to the online

survey. If necessary, permission from the moderators of the Facebook groups was asked before posting. We contacted respondents by calling or emailing them using the contact information on their websites, sending them direct messages via social media, replying to their comments on our Facebook posts and reaching out to our own personal contacts via WhatsApp.

Semi-structured interviews and surveys

Interviews on plant use to treat dysmenorrhea were conducted face-to-face or via (video) calls (Appendix B). Before starting an interview, we obtained informed consent from all participants, following the International Society of Ethnobiology Code of Ethics (ISE 2006). Surveys were set up using SurveyMonkey (<https://surveymonkey.com>), a website to help design and distribute online surveys (Appendix C). Surveys had a Dutch and an English version with the same questions. Survey data was collected between April and July 2022 (Appendix A). Dutch versions were posted via Dutch Facebook groups, Instagram, and WhatsApp. English versions were posted in English-language Facebook groups. Women who did not use plants to alleviate dysmenorrhea were encouraged to complete the survey as well, to gain more insight in the prevalence of such plant use. We did not know beforehand whether survey respondents used medicinal plants or not. Furthermore, questions concerning demography (e.g. gender, age, nationality) were asked. Questions about plant use were mandatory to answer, while questions about personal information were voluntary.

Literature research

We carried out literature research on Google Scholar and Scopus to find out what phytochemicals were present in plant taxa cited by our respondents, and if these chemicals were related to alleviating dysmenorrhea. Furthermore, we researched what frequently cited plant taxa in this study were also used in other countries against dysmenorrhea. Search terms such as “menstrual pain” or “painful period” or “period pain” were used in addition to “dysmenorrhea”. Other search terms included “herbal remedy”, “medicinal plant”, “herbs”, “phytochemicals”, “(chemical) compounds” and “tannins”. We collected further relevant articles by snowballing.

Data analysis

Respondents were asked to give common and/or scientific names of the plant taxa they used or advised to treat dysmenorrhea. If they used herbal products, we asked them to provide the plant names written on the label or we collected the name of the brand and/or the website they bought it from to find the associated plant taxa. Some informants sent pictures of the label of the product. Vernacular plant names were linked to scientific names using Dutch floras (Duistermaat 2020, Verhelst 2022). Scientific names were all verified using the World Flora Online (WFO 2024). When scientific names were “ambiguous”, we followed Duistermaat (2020).

Answers to the interviews and surveys were organized in a spreadsheet. The data collected consisted of vernacular plant names and origins, motivations for plant choice, plant parts and/or preparations. Similar reasons for plant use mentioned during interviews and surveys were lumped. We used R (version 4.4.1) and Rstudio (version 2024.04.2+764) for the graphs, with packages “dplyr” and “tidyverse” (Posit Software 2024, Urbanek *et al.* 2023, Wickham 2019, Wickham *et al.* 2023). A Chi-Square test of independence was performed in RStudio to determine associations between the occurrence of plant use and the respondents’ migration background. A p-value below 0.05 was considered significant.

Results

General responses

A total of 150 online surveys were collected. Another 13 in-depth interviews were conducted. Five respondents were excluded from the data set, because they did not self-identify as female, did not live in the Netherlands or Belgium, or did not mention their parents’ country of birth. Two respondents used plants for menopausal complaints only, which were also excluded from the data set. This left a total usable sample size of 156 respondents. Five respondents who only advised plants to others were excluded from our analysis of motivations behind plant use, to ensure that the reasons cited reflected the opinions of women who used plants.

The mean age of the respondents in the final sample was 36.2 ± 12.77 . Thirty-six respondents (23.1%) had at least one parent who was not of Dutch origin (the definition of a migrant in the Netherlands), all other respondents had native Dutch parents and were born in the Netherlands themselves. Of the 156 respondents, almost half used plants to alleviate dysmenorrhea, while a similar percentage did not (Fig. 1). A smaller number of people had used plants in the past but did not at the time of interviewing. Five respondents did not use plants for dysmenorrhea themselves but gave advice to other women about menstrual plants.

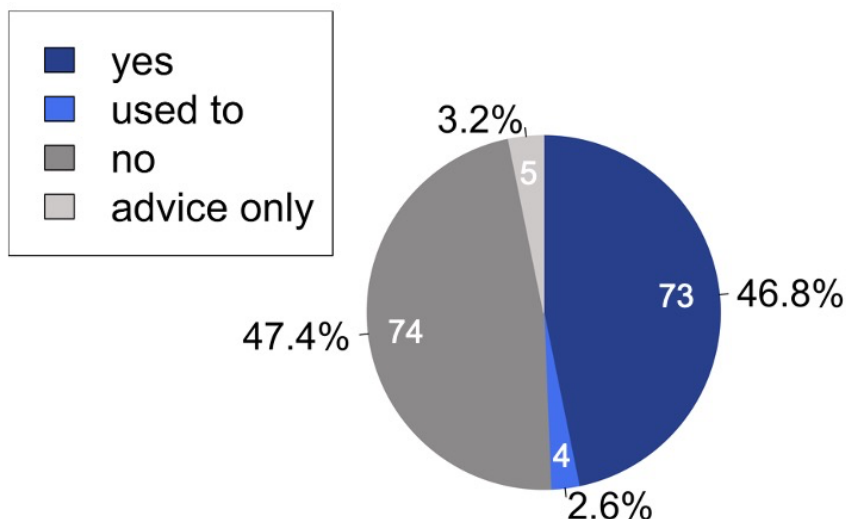


Figure 1. Pie chart displaying the proportions of answers given to the question: “Do or did you use plants to alleviate dysmenorrhea?” White numbers represent the actual number of respondents (n=156).

Plant taxa used to alleviate dysmenorrhea

Our respondents mentioned at least 87 different plant taxa in 39 plant families that they used to alleviate dysmenorrhea and/or advised to other women (Table 1). Twenty-five respondents mentioned where they obtained their medicinal plants: most either collected their own plants (17; 68%) or bought them in (online) herbal shops (7; 28%). Only one respondent supplemented self-gathered herbs with store-bought ones. Gardens (14; 56%), nature (5; 20%) and public parks (2; 8%) were the most popular plant gathering spots. Two respondents (8%) picked their own herbs, but did not mention where.

Plant names, both scientific and vernacular, acquired through herbal product labels, surveys and interviews corresponded to at least 87 scientific taxa, of which 65 could be traced to species level and 22 only to genus level. The five most often mentioned taxa were *Alchemilla* spp. (46.8% of respondents), *Matricaria* spp. (33.8%), *Rubus idaeus* (22.1%), *Zingiber officinale* (15.6%) and *Achillea millefolium* (14.3%) (Fig. 2). Nine plant taxa were mentioned more than five times in interviews and surveys. Most plant taxa belonged to the Lamiaceae (15 taxa; 17.2%), Asteraceae (11; 12.6%), Apiaceae (7; 8%), Rosaceae (7; 8%), Papaveraceae (4; 4.6%) and Solanaceae (4; 4.6%) families.

Our respondents used a total of 69 plant taxa to alleviate dysmenorrhea. Eighteen plant taxa were advised by other women but not confirmed as actually used, such as *Angelica dahurica*, *Tilia* sp. and *Eschscholzia californica*.

Some well-known sedative, but potentially toxic plant species were cited, such as *Atropa belladonna* and *Hyoscyamus niger* (Solanaceae). However, as these were used in homeopathic diluted preparations (D3 and D4 tinctures), their harmful effect is probably limited. Both Solanaceae species were mentioned once by the same respondent, who self-identified as a herbalist.

Table 1. Plant taxa mentioned by the 156 respondents as used and/or advised to treat dysmenorrhea, their plant parts, preparation and citation frequency.

Family	Taxon	Vernacular name*	Plant part used	Preparation	Citation frequency
Adoxaceae	<i>Viburnum opulus</i> L.	Gelderse roos	bark	tincture, supplement, powdered	3
	<i>Viburnum prunifolium</i> L.	cramp bark (English)	-	-	1
Amaranthaceae	<i>Beta vulgaris</i> L.	rode biet	-	-	1
Amaryllidaceae	<i>Allium sativum</i> L.	knoflook	-	infusion	1
Annonaceae	<i>Cananga odorata</i> (Lam.) Hook.f. & Thomson	ylang ylang (Filipino)	-	essential oil (externally)	1
Apiaceae	<i>Angelica archangelica</i> L.	grote engelwortel	roots	infusion	2
	<i>Angelica dahurica</i> (Hoffm.) Benth. & Hook.f. ex Franch. & Sav.	dahuriaanse engelwortel	roots	-	1
	<i>Angelica</i> sp.	engelwortel	whole plant	infusion	3
	<i>Foeniculum vulgare</i> Mill.	venkel	seeds	infusion	2
	<i>Petroselinum crispum</i> (Mill.) Fuss	peterselie	-	-	1
	<i>Pimpinella anisum</i> L.	anijs	-	-	1
	<i>Visnaga daucoides</i> Gaertn.	ammi visnaga (Latin)	-	-	1
Asparagaceae	<i>Asparagus racemosus</i> Willd.	shatavari (Indian)	fruit	-	1
Asteraceae	<i>Achillea millefolium</i> L.	duizendblad	aerial parts, leaves, flowers	infusion, tincture	11
	<i>Arnica montana</i> L.	arnica (Latin)	-	infusion	1
Asteraceae	<i>Artemisia vulgaris</i> L.	bijvoet	leaves	infusion	2
	<i>Bellis perennis</i> L.	madeliefje	-	salad	1
	<i>Calendula officinalis</i> L.	goudsbloem	flowers, petals	infusion	3
	<i>Echinacea</i> Moench	echinacea (Latin)	-	infusion	1
	<i>Matricaria chamomilla</i> L.	(echte) kamille	flowers, leaves, flower buds	infusion, homeopathic granules C30, bath, raw	9
	<i>Matricaria</i> sp.	kamille	flowers	infusion, tincture, essential oil in beeswax compress	17
	<i>Solidago virgaurea</i> L.	guldenroede	leaves	infusion, honey infusion	1
	<i>Tanacetum parthenium</i> (L.) Sch.Bip.	moederkruid	-	-	1
	<i>Taraxacum officinale</i> F.H.Wigg.	paardenbloem	leaves, roots	infusion	1

Ethnobotany Research and Applications

Berberidaceae	<i>Caulophyllum robustum</i> Maxim.	blue cohosh (English)	roots	-	1
Betulaceae	<i>Betula</i> sp.	berk	leaves	-	1
Brassicaceae	<i>Capsella bursa-pastoris</i> Medik.	herderstasje	-	infusion	1
Bromeliaceae	<i>Ananas comosus</i> (L.) Merr.	ananas	-	decoction in goat milk	1
Cannabaceae	<i>Cannabis sativa</i> L.	cannabis, wiet	female flowers, leaves, flowers	oil (internally), inhaling smoke, oil, infusion	10
	<i>Humulus lupulus</i> L.	hop	-	supplement	1
Caprifoliaceae	<i>Valeriana officinalis</i> L.	valeriaan	roots	infusion	4
Dioscoreaceae	<i>Dioscorea villosa</i> L.	wilde yam	roots	tincture, supplement, powdered	3
Ericaceae	<i>Gaultheria procumbens</i> L.	wintergreen	-	essential oil (externally)	1
Fabaceae	<i>Trifolium pratense</i> L.	rode klaver	flowers	infusion, extract, salad	5
Hypericaceae	<i>Hypericum perforatum</i> L.	Sint-Janskruid	leaves, flowers	infusion, oil (externally), honey infusion	5
Lamiaceae	<i>Glechoma hederacea</i> L.	hondsdrif	leaves	infusion, tincture	1
	<i>Lamium album</i> L.	witte dovenetel	aerial parts	infusion, tincture	2
	<i>Lamium</i> sp.	dovenetel	leaves	infusion	2
	<i>Lavandula angustifolia</i> Mill.	lavendel	flowers	oil (externally)	1
	<i>Lavandula</i> sp.	lavendel	flowers	oil (externally), infusion, tincture	4
	<i>Melissa officinalis</i> L.	citroenmelisse	(young) leaves	infusion, tincture	5
	<i>Mentha</i> sp.	(peper)munt	-	infusion	3
	<i>Nepeta cataria</i> L.	catnip (English)	-	infusion	1
	<i>Ocimum basilicum</i> L.	tropische basilicum	-	essential oil (externally)	1
	<i>Origanum</i> sp.	marjolein	-	-	1
	<i>Origanum vulgare</i> L.	wilde marjolein	-	-	1
	<i>Rosmarinus officinalis</i> L.	rozemarijn	leaves	-	2
	<i>Salvia</i> sp.	salie	leaves	infusion	4
	<i>Salvia officinalis</i> L.	(echte) salie	leaves	infusion	1
	<i>Thymus</i> sp.	tijm	-	-	1
	<i>Vitex agnus-castus</i> L.	monnikspeper	fruit, seeds	supplement, powdered, tincture, infusion	7
	<i>Cinnamomum</i> Schaeff.	kaneel	-	-	1
Malvaceae	<i>Tilia</i> sp.	linde	-	-	1
Melanthiaceae	<i>Trillium erectum</i> L.	trillium	roots	-	1
Myristicaceae	<i>Myristica fragrans</i> Houtt.	nootmuskaat	seeds	decoction in goat milk	1

Ethnobotany Research and Applications

Myrtaceae	<i>Melaleuca</i> sp.	minjak kaju putih (Indonesian)	-	oil	1
Onagraceae	<i>Oenothera</i> sp.	teunisbloem	seeds, flowers	oil (internally), oil, raw	4
Paeoniaceae	<i>Paeonia lactiflora</i> Pall.	Chinese pioenroos	roots	-	1
Papaveraceae	<i>Corydalis cava</i> (L.) Schweigg. & Körte	holwortel	-	-	1
	<i>Corydalis yanhusuo</i> (Y.H.Chou & Chun C.Hsu) W.T.Wang ex Z.Y.Su & C.Y.WU	yan hu suo (Chinese)	tubers	-	2
	<i>Eschscholzia californica</i> Cham.	slaapmutsje	aerial parts	-	1
	<i>Papaver rhoeas</i> L.	klaproos	petals	infusion	1
Passifloraceae	<i>Passiflora incarnata</i> L.	passiebloem	leaves	-	1
	<i>Passiflora</i> sp.	passiebloem	-	infusion	1
Pinaceae	<i>Pinus</i> sp.	den	leaves	infusion	1
Plantaginaceae	<i>Plantago</i> sp.	weegbree	leaves	infusion, tincture	2
Rhamnaceae	<i>Ziziphus jujuba</i> Mill.	jujube (English)	-	decoction with sugar (sweet tea)	1
Rosaceae	<i>Alchemilla</i> sp.	vrouwenmantel	(young) leaves, aerial parts, roots, flowers	infusion, tincture, honey infusion, decoction	36
	<i>Filipendula ulmaria</i> (L.) Maxim.	moerasspirea	-	-	4
	<i>Potentilla anserina</i> L.	zilver schoon	leaves	infusion, tincture	2
	<i>Rosa</i> sp.	roos	-	infusion	1
	<i>Rosa</i> sp. "Mister Lincoln"	roos	flowers	infusion, oil (externally)	1
	<i>Rubus idaeus</i> L.	framboos	leaves	infusion, tincture, decoction	17
	<i>Rubus</i> sp.	braam	leaves	infusion, tincture	4
	Rubiaceae	<i>Mitchella repens</i> L.	patrijsbes	leaves	-
Salicaceae	<i>Salix alba</i> L.	wilg	-	-	1
	<i>Salix</i> sp.	wilg	bark	infusion, tincture	7
Sapindaceae	<i>Dimocarpus longan</i> Lour.	longan (Vietnamese)	-	decoction with sugar (sweet tea)	1
Solanaceae	<i>Atropa belladonna</i> L.	wolfskers	roots, seeds	homeopathic D3 or D4 tincture	1
	<i>Hyoscyamus niger</i> L.	bilzekruid	aerial parts, seeds	homeopathic D3 or D4 tincture	1

Ethnobotany Research and Applications

	<i>Lycium chinense</i> Mill.	goji (Chinese)	fruit	decoction with sugar (sweet tea)	1
	<i>Withania somnifera</i> (L.) Dunal	ashwaganda (Indian)	roots	-	2
Theaceae	<i>Camellia sinensis</i> (L.) Kuntze	thee	leaves, flowers	salad, kombucha	1
Urticaceae	<i>Urtica dioica</i> L.	nettle (English)	-	infusion	1
	<i>Urtica sp.</i>	brandnetel	leaves	infusion	3
Verbenaceae	<i>Aloysia citrodora</i> Paláu	citroenverbena	-	infusion	1
Zingiberaceae	<i>Zingiber officinale</i> Roscoe	gember	roots	infusion, tincture, supplement, powdered, decoction, essential oil (externally), decocotion with sugar (sweet tea), external massage	12

* Name given by respondent or as written on herbal product label. Names are in Dutch unless mentioned otherwise.

- no information

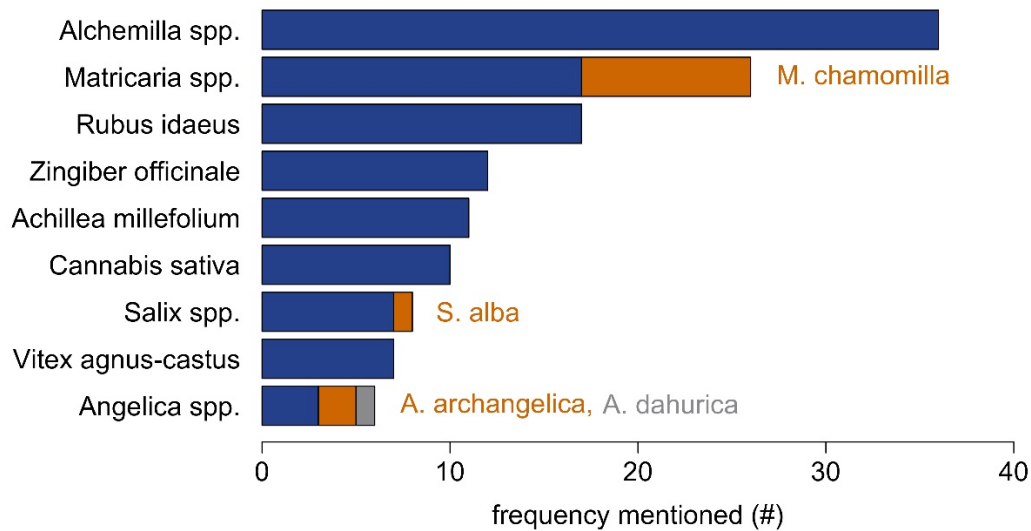


Figure 2. Most frequently mentioned plant taxa in the 156 interviews and surveys used or advised to alleviate dysmenorrhea. Some taxa were only identifiable to genus level, these were combined with mentioned species in the same genus (orange and grey).

Plant parts and preparations to alleviate dysmenorrhea

Our respondents mostly mentioned using the leaves of the plant, followed by flowers and roots (Table 2). The most frequently used preparation was an infusion (Table 3, Fig. 3). Yet, our respondents relatively often failed to mention used plant parts or preparations.

Table 2. The most frequently used plant parts to treat dysmenorrhea mentioned by our respondents (n=82). Percentages were calculated over the total number of cited plant parts per taxon.

plant part	frequency (#)	percentage (%)
leaves	54	23.9
flowers	24	10.6
roots	21	9.3
aerial parts	13	5.8
bark	9	4.0
unknown	84	37.2

Table 3. The most frequently used preparations to treat dysmenorrhea mentioned by our respondents (n=82). Percentages were calculated over the total number of cited preparations per taxon.

preparation	frequency (#)	percentage (%)
infusion	110	45.8
tincture	25	10.4
supplement	7	2.9
oil (externally)	5	2.1
powdered	5	2.1
oil (internally)	4	1.7
unknown	52	21.7



Figure 3. Infusions of (left to right, front to back) *Artemisia vulgaris*, fresh *Achillea millefolium*, dried *A. millefolium*, *Salix* sp., *Valeriana officinalis*, *Matricaria chamomilla*, *Rubus* sp. and *Salvia officinalis*, which were made by a respondent from plants collected from her nearby surroundings and used or advised to treat dysmenorrhea.

Matricaria spp., *Alchemilla* spp., *Rubus idaeus* and *Achillea millefolium* were mostly prepared as infusions. *Cannabis sativa* was most often taken orally as oil, although a few informants mentioned they smoked the marijuana to alleviate painful menstruation. **Ginger** (*Zingiber officinale*) had the most variation in preparations, such as a infusions, tinctures, external massages and decoctions. One respondent was excluded from this table, because she mentioned general preparations that could be used for all mentioned plants, not specific preparations per plant taxon.

Motivations for use of specific plants

Our respondents cited 20 different reasons for choosing specific plant taxa to alleviate dysmenorrhea (Fig. 4). The main arguments had to do with personal experience of efficacy and familiarity with the plant species (49.4% and 45.5% of respondents, respectively). Availability, recommendation by other people and lack of side effects were also frequently mentioned (42.9%, 19.5% and 13%). The price or taste of a herbal medicine were cited only once.

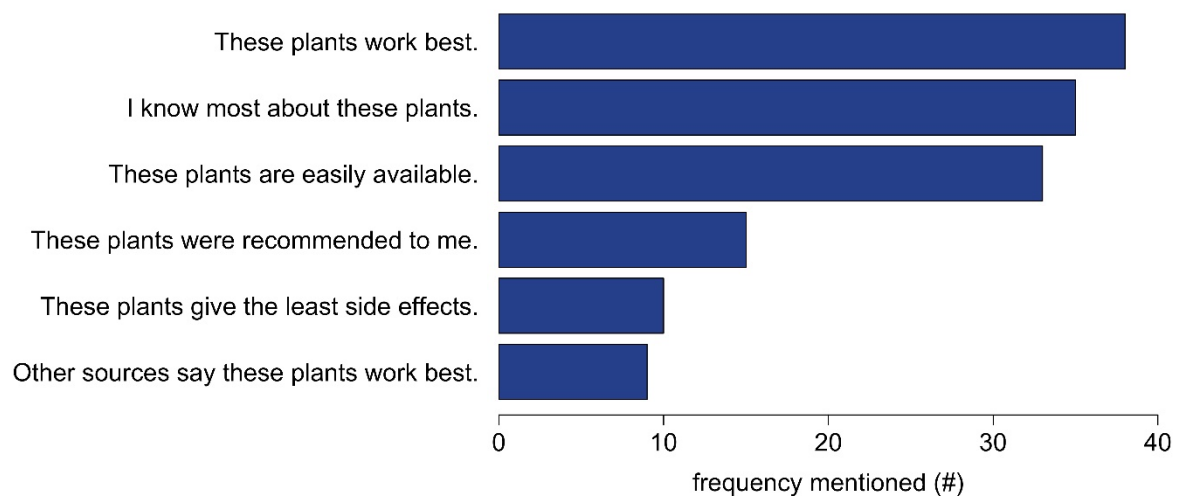


Figure 4. The most frequently mentioned reasons for using specific plant taxa to alleviate dysmenorrhea (n=77).

Motivations for medicinal plant use instead of conventional painkillers

Our respondents mentioned 21 reasons why they used plants to alleviate dysmenorrhea instead of (or in addition to) pharmaceutical painkillers (Fig. 5). The absence of side effects was the main reason to choose for herbal medicine (62.3%). The dependence on and distrust of the pharmaceutical industry and synthetic medicine was another strong motivation. For others, the use of medicinal plants was an important part of their culture or connection with nature. Fewer respondents used plants because painkillers did not treat the underlying causes of dysmenorrhea, plant use was part of their job, or they liked collecting plants.

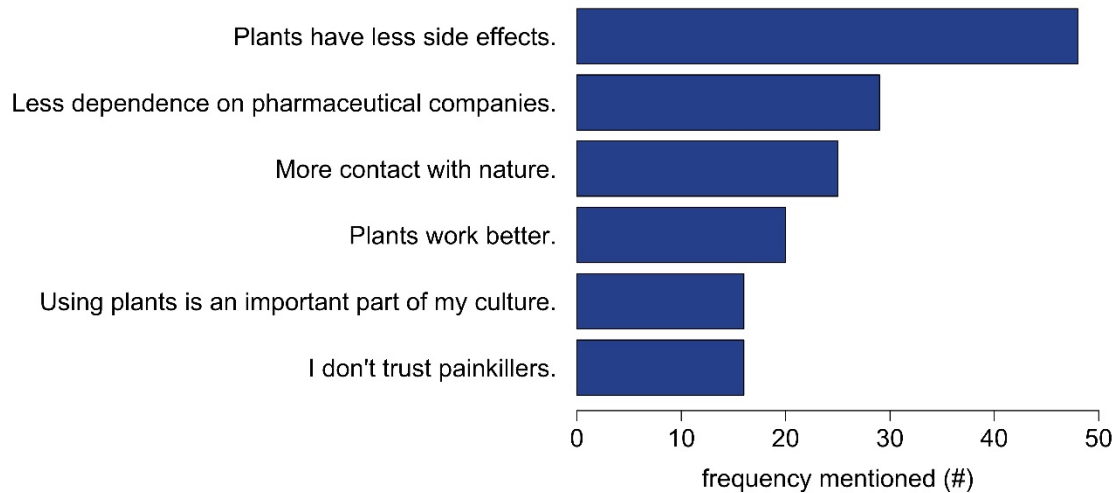


Figure 5. The most frequently mentioned reasons for the choice between medicinal plants versus painkillers (n=77).

Medicinal plant use and migration background

A Chi-Square test of independence was performed to determine associations between respondents with (n=36) or without migration background (n=120) and medicinal plant use (Table 4). We expected a significant relationship between migration background and medicinal plant use. Respondents who used medicinal plants in the past and present were grouped together. Respondents who did not use medicinal plants or only gave advice were also grouped together. The Chi-Square test ($X^2 = 0.43$, $df = 1$, $n = 156$, $p = 0.51$) did not yield significant results, indicating that medicinal plant use and migration background are not associated in our sample. Some respondents with a migration background used exotic plant species such as *Ananas comosus*, *Melaleuca* sp. and *Lycium chinense*. These plants were never used by native Dutch respondents. Other species, both exotic and native in the Netherlands, were used by respondents of all cultural backgrounds. Examples include *Zingiber officinale*, *Achillea millefolium* and *Withania somnifera*.

Table 4. Input for the Chi-Square test of independence to determine associations between our respondents' background (migrant/native) and answers to the question "Do or did you use plants to alleviate dysmenorrhea?" (yes/no).

respondent	yes	no
migrant	20	16
native	57	63

Discussion

Diversity of cited plant taxa and their use in other countries

This is the first study on medicinal plant use to alleviate dysmenorrhea by women in the Netherlands, giving us more insight in herbal treatments and reasons behind their use. Our results suggest that women in the Netherlands use and recommend a large variety of plant taxa to alleviate dysmenorrhea symptoms, although few species are used and advised frequently. The large number of plant taxa cited one or two times reflect taxa that have limited availability in the country or are not well known to alleviate dysmenorrhea. Interestingly, these taxa include both exotic plants (such as *Corydalis yanhusuo* and *Caulophyllum robustum*), but also common Dutch kitchen herbs such as *Mentha* spp., *Rosmarinus officinalis* and *Salvia officinalis*.

Alchemilla was the most cited plant taxon in this study, and its use against dysmenorrhea is described in multiple herbal manuals (Behrens *et al.* 2020, Harding 2005, Houdret 2012, Verhelst 2022). Furthermore, *Alchemilla* species are used to treat menstrual problems in Italy (*A. alpina* L., *A. vulgaris* L. and *A. xanthochlora* Rothm.), Serbia (*A. vulgaris*), Romania (*A. xanthochlora*), Montenegro (*A. vulgaris*) and Cameroon (*Alchemilla cryptantha* Steud. ex A.Rich.), indicating that *Alchemilla* is a significant genus in treatment of menstrual problems (Focho *et al.* 2009, Jarić *et al.* 2015, Menković *et al.* 2011, Motti *et al.* 2019, Tita *et al.* 2009). The same holds for other frequently cited plant taxa in this study. *Matricaria* spp., *Achillea millefolium* and *Zingiber officinale* are used similarly in Malaysia, India, Italy, Poland, Iran, Pakistan and Uganda, suggesting that they too possess phytochemicals that work directly on the female reproductive system (Aziz *et al.* 2018, Jiao *et al.* 2022, Kamatenesi-Mugisha & Oryem-Origa 2007, Kujawska & Hilgert 2014, Mirabi *et al.* 2014, Motti *et al.* 2019, Van Andel *et al.* 2014).

Rubus idaeus, *Cannabis sativa* and *Salix* spp., although frequently cited in our study, are incidentally reported to be specifically used for dysmenorrhea, although they are used in Serbia, Turkey, Montenegro, Australia, Italy and Romania for their astringent, antipyretic, analgesic, menstrual regulatory and anti-inflammatory properties (Jarić *et al.* 2015, Kaval *et al.* 2014, Menković *et al.* 2011, Motti *et al.* 2019, Sinclair *et al.* 2022, Tita *et al.* 2009). However, these medicinal properties are possibly essential in treating dysmenorrhea and may explain the frequent use of these plant taxa among respondents in this study.

Phytochemical properties of frequently used plants for dysmenorrhea

Medicinal plants contain various groups of phytochemicals, that may help alleviate dysmenorrhea in different ways. Tannins are a large group of phenolic compounds, that can be found in frequently mentioned plants, such as *Alchemilla* spp. and *Rubus idaeus*, which contain it in particularly high doses (Behrens *et al.* 2020, Boroja *et al.* 2018, Kanak *et al.* 2022, Maier *et al.* 2017). However, *Potentilla erecta* (L.) Rausch. and *Arctostaphylos uva-ursa* (L.) Spreng. contain comparable doses of tannins as *Alchemilla* spp. and *R. idaeus* (Maier *et al.* 2017), yet our respondents never mentioned them. This indicates that other reasons, such as availability or familiarity, may explain the frequent use of these species.

Dysmenorrhea is a result of the overproduction of prostaglandins in the uterus, thereby eliciting an inflammatory response (Latthe *et al.* 2011). Szmidt *et al.* (2020) reported that women with primary dysmenorrhea had significantly higher levels of oxidative stress compared to controls. Tannins are anti-inflammatory by inhibiting prostaglandin synthesis and lowering oxidative stress, and thus may help treat dysmenorrhea (Kanak *et al.* 2022, Qiuqian *et al.* 2021, Tong *et al.* 2022). Furthermore, tannins work as an astringent, which may constrict uterine tissues and decrease menstrual bleeding, but may also constrict inflamed mucous membranes (Behrens *et al.*, 2020; Boroja *et al.*, 2018; Verhelst, 2004). These characteristics of tannins may explain the frequent use of tannin-rich plant species in treating dysmenorrhea.

Other phytochemicals that may alleviate dysmenorrhea symptoms exhibit analgesic or sedative properties, such as alkaloids, salicinoids and cannabinoids. Alkaloids can be found in *Atropa belladonna*, *Hyoscyamus niger* and in other Solanaceae species, but also in *Achillea millefolium* and species in the Papaveraceae and Berberidaceae families (Shim *et al.* 2022, Verhelst 2022). Alkaloids block the neurotransmitter acetylcholine, therefore inhibiting the central and peripheral nervous system, creating an analgesic and spasmolytic effect (Lian *et al.* 2022, Prabhakar & Kumar 1994, Shim *et al.* 2022).

A. belladonna and *H. niger* were cited by one respondent in this study, yet they are known to be extremely toxic. They were prepared or purchased in a 1000 to 10,000 dilution (D3/D4), which may dilute alkaloids to such extent that they are safe to use (Schmoll *et al.* 2022). However, rare manufacturer errors in homeopathic dilutions resulting in high intake of *A. belladonna* have resulted in multiple cases of anticholinergic syndrome (Aviner *et al.* 2010, Glatstein *et al.* 2014, Schmoll *et al.* 2022). Since people still appear to use these dilutions, further research is warranted with the use of alkaloid preparations, especially since there is not much knowledge about their effectiveness and safety (Aviner *et al.* 2010).

Salicinoids and cannabinoids can be found in *Salix*, *Alchemilla*, *Filipendula ulmaria*, *Gaultheria procumbens* and *Cannabis sativa* (Table 1) (Verhelst 2022). These compounds, like alkaloids, show analgesic and/or sedative properties, although their mechanisms of action differ (Schurman *et al.* 2020, Tawfeek *et al.* 2021). Salicinoids, like tannins, inhibit prostaglandin synthesis and thus prevent pain and inflammation (Tawfeek *et al.* 2021). Cannabinoids bind to the cannabinoid receptors in the body, thus creating a sedative and anti-inflammatory effect (Schurman *et al.* 2020). However, all these phytochemicals are not the only ones that are analgesic or sedative, nor are they the sole working compounds in abovementioned plants. This indicates that dysmenorrhea can have different treatments, that depend on various plant compounds and mechanisms of action.

Availability of herbal medicine

The reasons our respondents gave for using certain plants corroborate the availability hypothesis by Albuquerque (2006) and Voeks (2004). Familiarity and accessibility were indeed important motivators for choosing certain plant taxa in this study. Although not all respondents mentioned the origin of their medicinal plants, our results suggest that gardens, nature and public green spaces are important sources for herbal medicine in the Netherlands. Indeed, two-thirds of Dutch households owns a garden and public green spaces are close at hand (CBS 2020, CBS 2023), where many of the mentioned species can be found, further confirming the availability hypothesis in our study. Furthermore, some of our respondents bought medicinal plants from (online) herbal shops. These stores often sell a large variety of herbs and preparations on a commercial scale. Research in other European countries, such as Germany and the United Kingdom, showed that the prevalence of commercialized herbal product use is relatively high (Du *et al.* 2014, Posadzki *et al.* 2013, Raynor *et al.* 2011). This illustrates that availability, at least in a western European context, stretches beyond presence of wild plants in nearby surroundings.

In other countries, such as India, the Philippines and Cameroon, processed herbal products are less available or preferred (Alinsug *et al.* 2022, Bhatia *et al.* 2015, Focho *et al.* 2009). Here, people preferred gathering medicinal plants themselves or cultivating them in their own gardens (Alinsug *et al.* 2022, Bhatia *et al.* 2015, Focho *et al.* 2009). Our results indicate that medicinal plant gathering and cultivation is also practiced in the Netherlands, despite its industrialized status and wide availability of in-store herbal products, thus demonstrating that interest in wild medicinal plants is present, as our respondents often mentioned that they valued connecting with nature.

Some plant taxa that were only cited once or twice can be found easily in the Netherlands as well, such as *Salvia officinalis*, *Rosmarinus officinalis* and *Foeniculum vulgare* (Duistermaat 2020). Perhaps our respondents did not know that these plants could alleviate dysmenorrhea. Experiencing positive effects was a more important motivator for choosing certain plant taxa than availability, at least according to our respondents. Women may generally experiment to find plants that work well for them, and easily available plants may get tried more often. Thus, indirectly, availability may still be a motivator. Future studies may focus on motivators and processes of plant choice in more detail, and in addition reconsider and broaden the mechanisms of the availability of medicinal plants (Albuquerque 2006, Voeks 2004).

Uncertainty of present botanical knowledge

Some important gaps in botanical knowledge were noted in this study. Surprisingly often, our respondents did not mention the plant parts or the preparations they used, although we specifically asked about them. Perhaps they did not find it important to mention or they did not know. In the case of store-bought herbal products, plant parts are often not included on the package label. Yet, the results of herbal remedies differ depending on which plant parts or preparations are used, sometimes in a harmful way (Verhelst 2022). Recognizing this is crucial to efficiency and safety of medicinal plant use. The lack of response from our informants implies that this knowledge was not present.

Species in the genus *Alchemilla* are difficult to identify and distinguish from one another, even for botanists (Duistermaat 2020, Kanak *et al.* 2022). Our respondents often mentioned the common Dutch name **vrouwenmantel**, which refers to the genus *Alchemilla*, not a specific species. In some cases, respondents did mention scientific species names: *A. vulgaris* and *A. mollis* (Buser) Rothm. However, *A. vulgaris* is a rare plant in the Netherlands (Duistermaat 2020). If our respondents said that they gathered *A. vulgaris* from their own gardens, they may have actually used *A. mollis*, since the latter is a common garden plant (Duistermaat 2020). In this case, our observed lack of knowledge in identifying *Alchemilla* species does not seem to impact their effectiveness, since the two species contain similar concentrations of tannins (Kurtul *et al.* 2022).

Species identification is likewise difficult for other frequently reported genera, such as *Matricaria*, *Salix* and *Angelica*. Respondents often mentioned the Dutch plant name or bought herbal products without information on the specific species. For wild plants, *Matricaria chamomilla* and *M. discoidea* DC. are likely to get collected, since they are very common chamomile species in the Netherlands (Duistermaat 2020). However, multiple look-a-like *Matricaria* species are abundant in the Netherlands as well, such as *Tripleurospermum maritimum* (L.) W.D.J.Koch and *Anthemis arvensis* L.. Common *Salix* species include *S. alba* and *S. x fragilis* L., as well as multiple other (hybridized) *Salix* species (Duistermaat 2020). For *Angelica*, two wild species are found in the Netherlands: *A. archangelica* and *A. sylvestris* L. (Duistermaat 2020). Species identification was even more complicated for herbal products with fragmented plant parts or without scientific species name on package labels.

As we show here, much is unclear concerning used plant parts and species, and our respondents' ability to recognize medicinal plants. Testing these aspects was challenging with the methods employed. For future research, taking plant

gathering walks and collecting voucher specimens will ensure accurate species identification and better reveal medicinal plant knowledge in the Netherlands. In addition, DNA and chemical analyses of herbal preparations could further aid identification of difficult species and elucidate concentrations of secondary metabolites (e.g. tannins) in frequently used medicinal plants.

Motivations behind plant use

Our respondents preferred herbal medicine to pharmaceutical painkillers because they experienced fewer side effects. Painkillers, especially paracetamol and NSAIDs, are prescribed by medics to treat dysmenorrhea (Iacovides *et al.* 2015, Schoep *et al.* 2019). Side effects of paracetamol are not very frequent, and mostly occur with longer usage (KNMP 2021). Yet, some women we interviewed mentioned that synthetic painkillers were taxing on the liver and kidneys; this may explain their reluctance to use them. NSAIDs, such as ibuprofen, have more frequent side effects, such as stomach and intestinal complaints, headache and vertigo (KNMP 2021). Women experiencing negative impacts from these painkillers may seek alternative treatments. The same accounts for people who distrust the pharmaceutical industry or want to be more in contact with nature.

Furthermore, our respondents often mentioned a perspective on health that was based on focusing on the whole person when treating physical problems instead of only relieving symptoms. This indicates that these women felt that synthetic painkillers only treated symptoms of dysmenorrhea, while they did not tackle the cause of the problem. While health perspectives may differ, the cited frequency of these reasons indicates that some women have an alternative perspective on dysmenorrhea than the one disseminated by health professionals, which focuses on treating dysmenorrhea symptoms with pharmaceutical painkillers (Schoep *et al.* 2019, Thuisarts.nl 2022). Medical professionals should take these views on synthetic painkillers seriously, since we have shown that they influence women's healthcare choices. Moreover, healthcare providers should ask their patients about medicinal plant use. Dutch patients often do not provide their doctor with this information, which may result in undesirable interactions with other medication (CBG-MEB 2024).

Our findings suggest that the use of medicinal plants and migration background are not associated in our sample. This does not match other studies: Surinamese migrants in the Netherlands and Polish migrants in Argentina often use medicinal plants from their country of origin (Kujawska & Hilgert 2014, Van Andel & Westers 2010). Our sample of migrant respondents was too low to show significant results. Perhaps social media was not an appropriate recruitment method for people with a migration background. Exotic plant shops in larger cities may be a promising source of data for future research. Some respondents with a migration background used plants from their country of origin which were never used by other Dutch respondents. Still, other exotic species were used by respondents of all cultural backgrounds. This indicates that these migrant respondents possess different plant knowledge or preferences than the native Dutch respondents.

Conclusion

This study is a valuable addition to current knowledge about herbal medicine use in the Netherlands. Our results could be useful for general practitioners, gynecologists and other medical professionals involved in women's health. We found that several frequently mentioned plant taxa (such as *Alchemilla*, *Matricaria*, *Rubus idaeus*, *Cannabis sativa*, *Salix* and *Zingiber officinale*) contain various phytochemicals with researched effectiveness in alleviating dysmenorrhea. Our results reflect that familiarity with certain herbal products is an important motivator for using them, together with availability and experienced benefits. Availability in a Dutch context includes home gardens, nature, public parks and herbal shops. We revealed a considerable knowledge gap in our respondents' ability to recognize species, which may be abridged by further studies. Motivators behind plant choice provide important context, although the methods used allowed limited nuances in respondents' answers. Future research to clarify these nuances may include more semi-structured interviews with more in-depth questions on motivators for plant choice.

Dysmenorrhea is common and impacts women's lives in a negative way. Supporting women with adequate healthcare may alleviate this negative impact. If women prefer plants over pharmaceutical painkillers, it is vital that these plants are safe to use and do not cause interactions with other medication. Furthermore, medicinal plants may be recommended by doctors as a viable alternative for pharmaceutical painkillers if they are easy and safe to use. Therefore, gaining more insight in women's healthcare choices and motivations is crucial in securing high quality and suitable healthcare for them, and this study is a step in that direction.

Declarations

List of abbreviations: NSAIDs - non-steroidal anti-inflammatory drugs; D3 - 1000x dilution (homeopathy); D4 - 10000x dilution (homeopathy)

Ethics approval and consent to participate: This research does not involve human clinical trials and does not subject participants to procedures or rules of behavior. Therefore, it does not need to comply to medical-ethical research laws in the Netherlands and does not need to get approved by an ethics committee (CCMO, <https://english.ccmo.nl/investigators/legal-framework-for-medical-scientific-research/your-research-is-it-subject-to-the-wmo-or-not>). However, we did conduct our study according to the Code of Ethics from the Society of Ethnobotany (ISE, <https://www.ethnobiology.net/what-we-do/core-programs/ise-ethics-program/code-of-ethics/code-in-english/>). This includes informing our respondents and obtaining their permission to record, use and publish their data prior to their participation in interviews or surveys, as is customary in the field of ethnobiology.

Consent for publication: Not applicable

Availability of data and materials: The authors declare that they have no competing interests.

Competing interests: The authors declare that they have no competing interests.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author contributions: BZ initiated the original idea, collected, curated and analyzed the data, and wrote the first draft of the paper. BZ and IPG developed the idea, methodology and completed project administration. IPG supplied resources. IPG and TvA provided supervision, validation and reviewed and edited the manuscript. All authors have carefully reviewed the paper and agreed with its submission for publication.

Acknowledgements

We would like to thank all interviewees and respondents for their time, enthusiasm and elaborate information.

Literature cited

Albuquerque UP. 2006. Re-examining hypotheses concerning the use and knowledge of medicinal plants: a study in the Caatinga vegetation of NE Brazil. *Journal of Ethnobiology and Ethnomedicine* 2(1):30.

Albuquerque UP, Da Cunha LVFC, De Lucena RFP, Alves RRN. 2014. *Methods and Techniques in Ethnobiology and Ethnoecology*. Humana Press, New York, USA.

Alinsug MV, Estandarte MHG, Somodio EMN, Sabarita MJJ, Deocarís CC. 2022. Biodiversity of ethnomedicinal plants from the B'laan Tribe in Mount Matutum Protected Landscape, Southern Mindanao, Philippines. *Biodiversitas* 23(1):554-563.

Armour M, Parry K, Manohar N, Holmes K, Ferfolja T, Curry C, MacMillan F, Smith CA. 2019. The Prevalence and Academic Impact of Dysmenorrhea in 21573 Young Women: A Systematic Review and Meta-Analysis. *Journal of Women's Health* 28(8):1161-1171.

Aviner S, Berkovitch M, Dalkian H, Braunstein R, Lomnický Y, Schlesinger M. 2010. Use of a Homeopathic Preparation for "Infantile Colic" and an Apparent Life-Threatening Event. *Pediatrics* 125(2):e318-e323.

Aziz MA, Khan AH, Ullah H, Adnan M, Hashem A, Abd_Allah EF. 2018. Traditional phytomedicines for gynecological problems used by tribal communities of Mohmand Agency near the Pak-Afghan border area. *Revista Brasileira de Farmacognosia* 28(4):503-511.

Behrens J, Curtis S, Green L, Ody P, Vilinac D. 2020. *Healing Herbs*. Dorling Kindersley Limited, United Kingdom.

Bhatia H, Pal Sharma Y, Manhas RK, Kumar K. 2015. Traditional phytoremedies for the treatment of menstrual disorders in district Udhampur, J&K, India. *Journal of Ethnopharmacology* 160:202-210.

Boroja T, Mihailović V, Katanić J, Pan SP, Nikles S, Imbimbo P, Monti DM, Stanković N, Stanković MS, Bauer R. 2018. The biological activities of roots and aerial parts of *Alchemilla vulgaris* L. *South African Journal of Botany* 116:175-184.

CBG-MEB. Interactie tussen kruiden en medicijnen: uitleg voor zorgverleners. 2024. <https://www.cbg-meb.nl/onderwerpen/medicijninformatie-kruiden/informatie-voor-zorgverleners> (Accessed 22/07/2024).

CBS. Hoe wordt de Nederlandse bodem gebruikt? 2020. <https://longreads.cbs.nl/nederland-in-cijfers-2020/hoe-wordt-de-nederlandse-bodem-gebruikt/> (Accessed 04/07/2023).

- CBS. Monitor Brede Welvaart & de Sustainable Development Goals. 2021. <https://longreads.cbs.nl/monitor-brede-welvaart-en-sdgs-2021/overkoepelend-beeld-monitor-brede-welvaart-en-de-sustainable-development-goals-2021/> (Accessed 04/07/2024).
- CBS. Huishoudens nu. 2023. <https://www.cbs.nl/nl-nl/visualisaties/dashboard-bevolking/woonsituatie/huishoudens-nu> (Accessed 04/07/2024).
- CBS. Bevolkingsteller. 2024. <https://www.cbs.nl/nl-nl/visualisaties/dashboard-bevolking/bevolkingsteller> (Accessed 11/09/2024).
- De Jong R, Blom C, Van Berkel J, Bogaart P, Driessen C, De Jongh-Van de Pol L, Lof M, Mosterd R, Schenau S. 2022. Natuurlijk kapitaal en brede welvaart in Nederland. CBS, The Netherlands.
- Du Y, Wolf I-K, Zhuang W, Bodemann S, Knöss W, Knopf H. 2014. Use of herbal medicinal products among children and adolescents in Germany. *BMC Complementary and Alternative Medicine* 14(1):218.
- Duistermaat H. 2020. Heukels' Flora van Nederland. Noordhoff Uitgevers, The Netherlands.
- Focho DA, Ndam WT, Fonge BA. 2009. Medicinal plants of Aguambu - Bamumbu in the Lebialem highlands, southwest province of Cameroon. *African Journal of Pharmacy and Pharmacology* 3(1):1-13.
- Gaoue OG, Coe MA, Bond M, Hart G, Seyler BC, McMillen H. 2017. Theories and Major Hypotheses in Ethnobotany. *Economic Botany* 71(3):269-287.
- Gavin MC. 2009. Conservation Implications of Rainforest Use Patterns: Mature Forests Provide More Resources but Secondary Forests Supply More Medicine. *Journal of Applied Ecology* 46(6):1275-1282.
- Glatstein M, Danino D, Wolyniez I, Scolnik D. 2014. Seizures caused by ingestion of *Atropa belladonna* in a homeopathic medicine in a previously well infant: case report and review of the literature. *American Journal of Therapeutics* 21(6):e196-e198.
- Gyn&Co, Mawet M. Tips om een pijnlijke menstruatie te verlichten. 2016. <https://www.gynandco.be/nl/tips-om-een-pijnlijke-menstruatie-te-verlichten/> (Accessed 22/03/2022).
- Hadjou OK, Jouannin A, Lavoue V, Leveque J, Esvan M, Bidet M. 2022. Prevalence of dysmenorrhea in adolescents in France: Results of a large cross-sectional study. *Journal of Gynecology, Obstetrics and Human Reproduction* 51(3).
- Harding J. 2005. *Het Grote Kruidenboek*. Parragon Books Ltd, United Kingdom.
- Harel Z. 2008. Dysmenorrhea in Adolescents. *Annals of the New York Academy of Sciences* 1135(1):185-195.
- Hilgers T. 2021. *Bijvoet: Het Magische Vrouwen- & Sjamanenkruid*. Drukkerij Kempers, The Netherlands.
- Houdret J. 2012. *Minibijbel Kruiden Kweken*. Veltman Uitgevers, The Netherlands.
- Iacovides S, Avidon I, Baker FC. 2015. What we know about primary dysmenorrhea today: a critical review. *Human Reproduction Update* 21(6):762-178.
- ISE. ISE Code of Ethics. 2006. <https://www.ethnobiology.net/what-we-do/core-programs/ise-ethics-program/code-of-ethics/> (Accessed 24/03/2022).
- Jarić S, Mačukanović-Jocić M, Djurdjević L, Mitrović M, Kostić O, Karadžić B, Pavlović P. 2015. An ethnobotanical survey of traditionally used plants on Suva planina mountain (south-eastern Serbia). *Journal of Ethnopharmacology* 175:93-108.
- Jiao M, Liu X, Ren Y, Wang Y, Cheng L, Liang Y, Li Y, Zhang T, Wang W, Mei Z. 2022. Comparison of Herbal Medicines Used for Women's Menstruation Diseases in Different Areas of the World. *Frontiers in Pharmacology* 12.
- Kamatenesi-Mugisha M, Oryem-Origa H. 2007. Medicinal plants used in some gynaecological morbidity ailments in western Uganda. *African Journal of Ecology* 45(1):34-40.
- Kanak S, Krzemińska B, Celiński R, Bakalczuk M, Katarzyna Dos Santos S. 2022. Phenolic Composition and Antioxidant Activity of *Alchemilla* Species. *Plants* 11(20):2709.

- Kaval I, Behçet L, Cakilcioglu U. 2014. Ethnobotanical study on medicinal plants in Geçitli and its surrounding (Hakkari-Turkey). *Journal of Ethnopharmacology* 155(1):171-184.
- KNMP. Ibuprofen. 2021. <https://www.apotheek.nl/medicijnen/ibuprofen#wat-zijn-mogelijke-bijwerkingen> (Accessed 27/04/2022).
- KNMP. Paracetamol. 2021. <https://www.apotheek.nl/medicijnen/paracetamol?product=paracetamol#wat-zijn-mogelijke-bijwerkingen> (Accessed 27/04/2022).
- KNMP. Menstruatieklachten. 2021. <https://www.apotheek.nl/klachten-ziektes/menstruatieklachten> (Accessed 22/03/2022).
- Kujawska M, Hilgert NI. 2014. Phytotherapy of Polish migrants in Misiones, Argentina: Legacy and acquired plant species. *Journal of Ethnopharmacology* 153(3):810-830.
- Kurtul E, Eryilmaz M, Sarialtin SY, Tekin M, Acikara ÖB, Çoban T. 2022. Bioactivities of *Alchemilla mollis*, *Alchemilla persica* and Their Active Constituents. *Brazilian Journal of Pharmaceutical Sciences* 58.
- Latthe PM, Champaneria R, Khan KS. 2011. Dysmenorrhoea. *BMJ Clinical Evidence* 2011.
- Lian W, Wang Y, Zhang J, Yan Y, Xia C, Gan H, Wang X, Yang T, Xu J, He J, Zhang W. 2022. The genus *Datura* L. (Solanaceae): A systematic review of botany, traditional use, phytochemistry, pharmacology, and toxicology. *Phytochemistry* 204:113446.
- Maier M, Oelbermann A-L, Renner M, Weidner E. 2017. Screening of European medicinal herbs on their tannin content—New potential tanning agents for the leather industry. *Industrial Crops and Products* 99:19-26.
- Mariappen U, Chew KT, Zainuddin AA, Mahdy ZA, Abdul Ghani NA, Grover S. 2022. Quality of life of adolescents with menstrual problems in Klang Valley, Malaysia: A school population-based cross-sectional study. *BMJ Open* 12(1).
- Martin GJ. 1995. *Ethnobotany: A Methods Manual*. Springer, Boston, USA.
- Menković N, Šavikin K, Tasić S, Zdunić G, Stešević D, Milosavljević S, Vincek D. 2011. Ethnobotanical study on traditional uses of wild medicinal plants in Prokletije Mountains (Montenegro). *Journal of Ethnopharmacology* 133(1):97-107.
- Mirabi P, Alamolhoda SH, Esmailzadeh S, Mojab F. 2014. Effect of medicinal herbs on primary dysmenorrhoea- a systematic review. *Iranian Journal of Pharmaceutical Research* 13(3):757-767.
- Moerman D. Native American Ethnobotany Database. 1977. <http://naeb.brit.org/> (Accessed 23/03/2022).
- Motti R, Bonanomi G, Emrick S, Lanzotti V. 2019. Traditional Herbal Remedies Used in women's Health Care in Italy: a Review. *Human Ecology* 47(6):941-972.
- Nabielek K, Hamers D. 2015. *De stad verbeeld*. Uitgeverij PBL, Den Haag, The Netherlands.
- Natuurmonumenten. Wildpluk. n.d. <https://www.natuurmonumenten.nl/natuurgebieden/gebiedsregels/wildpluk> (Accessed 04/07/2023).
- NDFD. Verspreidingsatlas. Naamlijst van de Nederlandse Vaatplanten. 2020. <https://www.verspreidingsatlas.nl/soortenlijst/vaatplanten> (Accessed 21/05/2023).
- Overheid.nl. Wetboek van Strafrecht. 2023. <https://wetten.overheid.nl/BWBR0001854/2023-07-01#BoekTweede> (Accessed 04/04/2023).
- Posadzki P, Watson LK, Alotaibi A, Ernst E. 2013. Prevalence of herbal medicine use by UK patients/consumers: a systematic review of surveys. *Alternative and Complementary Medicine* 18(1):19-26.
- Posit Software. RStudio. 2024. <https://posit.co/>
- Prabhakar E, Kumar NVN. 1994. Spasmogenic effect of *Datura metel* root extract on rat uterus and rectum smooth muscles. *Phytotherapy Research* 8(1):52-54.
- Qiujuan Y, Zongcai F, Liping H, Jingwei H, Zhongliu Z, Fang L. 2021. Ellagic acid (EA), a tannin was isolated from *Eucalyptus citriodora* leaves and its anti-inflammatory activity. *Medicinal Chemistry Research* 30(12):2277-2288.

- Raynor DK, Dickinson R, Knapp P, Long AF, Nicolson DJ. 2011. Buyer beware? Does the information provided with herbal products available over the counter enable safe use? *BMC Medicine* 9(1):94.
- Sawalha AF, Sweileh WM, Zyoud SH, Jabi SW. 2008. Self-therapy practices among university students in Palestine: Focus on herbal remedies. *Complementary Therapies in Medicine* 16(6):343-349.
- Schmoll S, Romanek K, Zorn G, Eiglmeier H, Eyer F. 2022. Anticholinergic syndrome after atropine overdose in a supposedly homeopathic solution: a case report. *Clinical Toxicology* 60(2):252-254.
- Schoep ME, Nieboer TE, van der Zanden M, Braat DDM, Nap AW. 2019. The impact of menstrual symptoms on everyday life: a survey among 42879 women. *American Journal of Obstetrics and Gynecology* 220(6):569.e1-e7.
- Schurman LD, Lu D, Kendall DA, Howlett AC, Lichtman AH. 2020. Molecular Mechanism and Cannabinoid Pharmacology. In: Nader MA, Hurd YL (eds). *Substance Use Disorders: From Etiology to Treatment*. Springer International Publishing, Cham, Switzerland, Pp. 323-353.
- Shetty GB, Shetty B, Mooventhan A. 2018. Efficacy of Acupuncture in the Management of Primary Dysmenorrhea: A Randomized Controlled Trial. *Journal of Acupuncture and Meridian Studies* 11(4):153-158.
- Shim KH, Kang MJ, Sharma N, An SSA. 2022. Beauty of the beast: anticholinergic tropane alkaloids in therapeutics. *Natural Products and Bioprospecting* 12(1).
- Sinclair J, Armour S, Akowuah JA, Proudfoot A, Armour M. 2022. "Should I Inhale?"—Perceptions, Barriers, and Drivers for Medicinal Cannabis Use amongst Australian Women with Primary Dysmenorrhoea: A Qualitative Study. *International Journal of Environmental Research* 19(3).
- Staatsbosbeheer. Toegangsregels | Wildplukken. 2023. <https://www.staatsbosbeheer.nl/Contact/toegangsregels/wildplukken> (Accessed 04/07/2023).
- Szmidt MK, Granda D, Sicinska E, Kaluza J. 2020. Primary Dysmenorrhea in Relation to Oxidative Stress and Antioxidant Status: A Systematic Review of Case-Control Studies. *Antioxidants* 9(10).
- Tawfeek N, Mahmoud MF, Hamdan DI, Sobeh M, Farrag N, Wink M, El-Shazly AM. 2021. Phytochemistry, Pharmacology and Medicinal Uses of Plants of the Genus *Salix*: An Updated Review. *Frontiers in Pharmacology* 12.
- Thuisarts.nl. Ik heb veel pijn als ik ongesteld ben (menstruatiepijn). 2022. <https://www.thuisarts.nl/bloed-uit-vagina/ik-heb-veel-pijn-als-ik-ongesteld-ben-menstruatiepijn> (Accessed 22/03/2022).
- Tita I, Mogosanu G, Tita M. 2009. Ethnobotanical inventory of medicinal plants from the South-West of Romania. *Farmacia* 57:141-156.
- Tong Z, He W, Fan X, Guo A. 2022. Biological Function of Plant Tannin and Its Application in Animal Health. *Frontiers in Veterinary Science* 8.
- Unsal A, Ayranci U, Tozun M, Arslan G, Calik E. 2010. Prevalence of dysmenorrhea and its effect on quality of life among a group of female university students. *Upsala Journal of Medical Sciences* 115(2):138-145.
- Urbanek S, Bibiko H-J, Iacus SM. R. 2023. <https://www.r-project.org/>
- Van An del T, Westers P. 2010. Why Surinamese migrants in the Netherlands continue to use medicinal herbs from their home country. *Journal of Ethnopharmacology* 127(3):694-701.
- Van An del T, De Boer HJ, Barnes J, Vandebroek I. 2014. Medicinal plants used for menstrual disorders in Latin America, the Caribbean, sub-Saharan Africa, South and Southeast Asia and their uterine properties: A review. *Journal of Ethnopharmacology* 155(2):992-1000.
- Vandebroek I, Balick M, Yukes J, Durán L, Kronenberg F, Wade C, Ososki A, Cushman L, Lantigua R, Mejía M, Robineau L. 2007. Use of Medicinal Plants by Dominican Immigrants in New York City for the Treatment of Common Health Conditions: A Comparative Analysis with Literature Data from the Dominican Republic. In: Pieroni A, Vandebroek I (eds). *Traveling Cultures and Plants*. Berghahn Books, New York, USA, Pp. 39-63.
- Verhelst G. 2022. *Groot Handboek Geneeskrachtige Planten*. BVBA MANNAVITA, Belgium.

Voeks RA. 2004. Disturbance Pharmacopoeias: Medicine and Myth from the Humid Tropics. *Annals of the American Association of Geographers* 94(4):868-88.

WFO. The World Flora Online. 2024. <https://worldfloraonline.org> (Accessed 23/09/2024).

Wickham H. Welcome to the tidyverse. 2019. <https://tidyverse.tidyverse.org/index.html>

Wickham H, François R, Henry L, Müller K, Vaughan D. *dplyr: A Grammar of Data Manipulation*. 2023. <https://dplyr.tidyverse.org/>

Xu Y, Yang Q, Wang X. 2020. Efficacy of herbal medicine (cinnamon/fennel/ginger) for primary dysmenorrhea: a systematic review and meta-analysis of randomized controlled trials. *Journal of International Medical Research* 48(6).

Zannoni L, Giorgi M, Spagnolo E, Montanari G, Villa G, Seracchioli R. 2014. Dysmenorrhea, Absenteeism from School, and Symptoms Suspicious for Endometriosis in Adolescents. *Journal of Pediatric and Adolescent Gynecology* 27(5):258-265.

Graphical abstract



Appendix A: All Facebook groups in which we posted our interview requests and survey links. Surveys were posted in Dutch and English.

Facebook group	1st post date	2nd post date	3rd post date
Kruiden en hun magische werking	3-4-2022	11-4-2022	9-7-2022
Kruiden	3-4-2022	11-4-2022	9-7-2022
De Herborist	9-7-2022	x	x
t Kruidenhoekje	3-4-2022	11-4-2022	9-7-2022
Wageningen Student Plaza	5-4-2022	11-4-2022	9-7-2022
Kruiden en Wildpluk	3-4-2022	11-4-2022	9-7-2022
Gezond met kruiden en voeding	9-7-2022	x	x
Bereidingen met kruiden, wildpluk..	3-4-2022	11-4-2022	9-7-2022
Wageningen Student Plants	5-4-2022	11-4-2022	9-7-2022
Surinaamse kruiden, geneesmiddelen, oso dresi	9-7-2022	x	x
Geneeskrachtige werking van planten en kruiden	9-7-2022	x	x
I LOVE SURINAME	9-7-2022	x	x
Expats in The Netherlands	10-4-2022	9-7-2022	x
Netherlands Expats Forum - Dutch - Expats NL	10-4-2022	9-7-2022	x
Molukkers in Nederland	10-4-2022	9-7-2022	x
Surinamers	10-4-2022	9-7-2022	x
Turkse dames bij elkaar	9-7-2022	x	x
eigen facebook	10-4-2022	x	x
kruidentaal	9-7-2022	x	x
kruiden.zalven.tincturen gezondheid	9-7-2022	x	x
Kruiden kracht	9-7-2022	x	x
kruiden (medume vrienden)	9-7-2022	x	x
eetbare wilde planten (en paddestoelen en dieren enzo)	9-7-2022	x	x
echte beginnersgroep voor het herkennen en gebruiken van kruiden	9-7-2022	x	x
het kruiden- en gezondheidshoekje	9-7-2022	x	x
de kracht van de natuur; medicinale, geneeskrachtige en rituele planten	9-7-2022	x	x
eetbare wilde planten	11-7-2022	x	x
eetbare/geneeskrachtige (wilde) planten	16-7-2022	x	x
international students Utrecht	11-7-2022	x	x
Utrecht international students	11-7-2022	x	x
respondenten gezocht (onderzoek, enquête, vragenlijst, scriptie, afstudeer)	11-7-2022	x	x
Respondenten gezocht!	11-7-2022	x	x
Spiritualiteit, informatie, kennis, kaarten, kruiden, magie, inzicht	11-7-2022	x	x

Appendix B: English version of the questions asked during interviews, including their follow-up questions.

1. Which plant species do you use and/or advise to alleviate menstrual pain?
 - corresponding scientific names
 - language of vernacular name if not clear
 2. Why do you choose this species and not other species that could also treat menstrual pain?
 3. How do you prepare this species?
 - plant part(s)
 - dried or fresh?
 - how much of the plant do you use (quantity)
 - mode of preparation: tincture, tea, decoction, etc.?
 4. How do you apply this species?
 - how much of the preparation?
 - how often should you apply the preparation?
 - when should you apply the preparation (before menstruation, during, etc.)?
 5. Which of these plant species do you use yourself? Are there any species you do not advise but do use yourself?
 - if new plant species get mentioned, repeat question 1 to 4
 - follow up question: Why do you not advise this species?
- About species that interviewees use themselves:**
6. Where did you collect these species?
 7. How do you know that these species alleviate menstrual pain? Where did you collect that information?
 8. Do you also use other treatments, other than medicinal plants, against menstrual pain?
 9. Why do you choose for medicinal plants to treat menstrual pain instead of synthetic painkillers?
 10. On a scale from 0 tot 10 (0 = does not work, 10 = all pain is gone), how well does this species treat menstrual pain?

Personal information

- Age, gender, occupation
- Did you follow a herbology/phytotherapy course? If yes, which?
- In which country was your father born?
- In which country was your mother born?
- In which country were you born?
- How long have you been living in the Netherlands?

When women only used plants, but did not advise them, question 5 was omitted and all questions were only asked about the plants they used.

Appendix C: English version of the questions asked during surveys, including their multiple choice response options.

1. Do you use plants to alleviate your menstrual pain?

- No

- Yes. Please write down your used plant species in the following way: plant name, Latin plant name (e.g. *Foeniculum vulgare*), used plant part, how you apply the plant (e.g as tea).

2. Why do you choose these plant species?

- I know the most about these species.

- They are easily available.

- They work best for me.

- They give the least side effects.

- Someone recommended these species to me.

- These plant species are important in my culture.

- I don't use plants

- Other reasons or more explanation on chosen answers:

3. Do you use other treatments to alleviate menstrual pain? If yes, which?

- heat/warmth

- other painkillers such as paracetamol, ibuprofen, etc.

- exercise/sport

- rest

- no other treatments

- Other treatments or more explanation on chosen answers:

4. Why do you use plants instead of (or in addition to) painkillers such as paracetamol and ibuprofen?

- Plants have less side effects.

- Less dependence on pharmaceutical companies.

- I don't trust painkillers.

- Plants are cheaper.

- Using medicinal plants is an important part of my culture.

- Plants work better.

- More connection with nature.

- I don't use plants

- Other reasons or more explanation on chosen answers:

5. What is your age?

6. What is your gender?

- male

- female

- other

- I'd rather not answer this question.

7. What is your mother's country of origin?

8. What is your father's country of origin?

9. What is your own country of origin?

10. How long have you been living in the Netherlands? (If you're an international student, please indicate that here.)