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ORIGINAL RESEARCH PAPER

Ethnobotanical uses of wild taxa as galactagogues in Sicily (Italy)

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Abstract

Breastfeeding furnishes optimal nutrition, immune support, and a multitude of health benefits to mothers and newborns. Since ancient times plants have been employed as galactagogues in the folk medicine of many human cultures. In Sicily, a region with great floristic diversity in the Mediterranean area, where a conspicuous pool of species is traditionally used for food and aromatic, cosmetic, handicraft, agricultural, forestry, and medicinal purposes, some people recognize the galactagogue properties of some spontaneous plants.

The goal of this study was to identify wild plants with galactagogue properties and vegetable-food remedies traditionally used by women during breastfeeding to increase milk production. It was conducted in the Madonie territory (province of Palermo) by interviewing a sample of 105 people that was divided into three age groups.

Ethnobotanical investigations revealed a total of 34 species, belonging to 11 families and 25 genera, used as galactagogues. For each taxon, the parts used, the methods of preparation, and the phytochemical profiles according to the literature were reported. The most represented family was Asteraceae, with 12 genera and 17 species, the majority of which contained latex.

The most frequently used parts of the galactagogue plants were leaves (69%) that were mainly eaten as cooked vegetables, raw in salads, or utilized as an infusion tea. The species cited in this study are mainly wild traditional vegetables with high nutritional profiles that could improve the quality and the quantity of the milk produced. The study found that older people represent a precious source of information to help younger people preserve the cultural identity of the territory.

Keywords

breastfeeding; galactagogue plants; phytoestrogens; ethnobotanical investigations; Madonie territory

Introduction

Plants are rich natural sources of phytochemicals and essential nutrients that can both serve as appropriate chemical weapons against diseases, as well as cure disturbances in the normal physiological functions of the body [1]. In particular, phytoestrogens are a group of plant-derived compounds whose chemical structure is similar to animal and human estrogens [2–10]. They include a wide variety of secondary metabolites, i.e., hydroxybenzoic acid, hydroxycinnamic acids, anthocyanins, proanthocyanidins, flavonols, flavones, flavonones, isoflavones, stilbenes, and lignins, which are involved in protecting plants against ultraviolet radiation, aggression by pathogens, or stress-related responses. It has been reported that some terpenoids and saponins possess similar phytoestrogen effects [3–5,7,11–27]. Several hundreds of these molecules are found in edible parts of plants, such as seeds, roots, stems, leaves, and fruit. They are common micronutrients in the human diet and have potential female health benefits because of their potent free radical scavenging properties and antioxidant activities [7,21,22,26]. Galactagogues are a group of substances or medicines either proven or believed to aid lactation during initiation and maintenance periods, increasing the human breast milk supply [28–31]. Since the earliest times of mankind, the delicate task of ensuring the survival of the human species has been related to women's fertility and their ability to raise children.

Essentially, breast milk is the most complete source of nutrition for infants; the milk, in addition to the appropriate amounts of carbohydrates, proteins, fats, vitamins, and minerals, includes hormones, digestive enzymes, and antibodies that assist the infant in regulating metabolic functions, properly digesting food, and strengthening the immune system [32]. Breast milk reduces the incidence of sudden infant death syndrome (SIDS), allergic/hypersensitivity diseases, and development of type 1 and type 2 diabetes mellitus [29,33–35]. Moreover, breast milk flow improves maternal health by reducing postpartum bleeding, excess weight gain, uterine involution, postpartum depression, and lactational amenorrhea [1,36]. Some studies have even shown that breastfeeding reduces the risk of osteoporosis for women, as well as the incidence of breast and ovarian cancers [35,37,38]. However, the number of women with insufficient milk production is increasing worldwide [1,29,39] and several factors could be responsible for the low milk supply, such as insufficient mammary tissue, medications, retained placenta, diseases, metabolic conditions (e.g., obesity), previous breast surgeries, caesarean section, and hormonal disorders. Other causes are related to environmental pollution, chemicals, pesticides, and medications that may interfere with female sex hormones, including those that affect breast development and milk production [1,39].

Lactation refers to the process of the production and secretion of milk from the mammary glands. This complex physiologic process involves physical and emotional components, and the interaction of multiple hormonal factors, such as estrogen, prolactin, and progesterone [40]. The process of milk protein synthesis also requires the availability of amino acids and a large supply of energy [1,41–43]. This suggests that nutrition plays an essential role in increasing milk protein synthesis.

There are some medications referred to as galactagogues, which assist in the initiation, maintenance, or augmentation of maternal milk production [44]. Most of these drugs (metoclopramide, domperidone, sulpride, and chlorpromazine) exert their mechanism of action through antagonism of dopamine D2 receptors, resulting in increased prolactin secretion. However, they are associated with unwanted side effects, such as sedation, restlessness, drowsiness, depression, weight gain, gastrointestinal disturbances, headache, nausea, and dry mouth [1,45–48]. Thus, these facts encourage the search for safer and more natural sources of treatment. Since the earliest of times, a multitude of galactagogue plants has been used in the folk medicine of all human cultures. Galactagogue herbs exist, in various dosages, forms, and preparations, including crude seeds, capsules containing dried seed powder, extract tincture, decoctions and infusion tea, pressed sap of fresh plants, and admixtures to food.

In several cultures, some galactagogue plants are widely utilized, such as *Trigonella foenum-graecum* L. (fenugreek), *Asparagus racemosus* L. (wild asparagus), *Galega officinalis* L. (goat's rue), *Silybum marianum* L. (milk thistle), *Medicago sativa* L. (alfalfa), and *Foeniculum vulgare* Mill. subsp. *vulgare* (fennel) [1,23,49]. Other traditional plants employed to enhance milk production are: *Pimpinella anisum* L., *Cnicus benedictus* L., *Borago officinalis* L., *Carum carvi* L., *Vitex agnus-castus* L., *Taraxacum officinale* Weber, *Anethum graveolens* L., *Althaea officinalis* L., *Urtica dioica* L., *Avena sativa* L., *Trifolium pretense* L., *Rubus idaeus* L., *Verbena officinalis* L., *Allium sativum* L., *Humulus lupulus* L., *Hibiscus sabdariffa* L., *Moringa oleifera* Lam, and *Gunnera perpensa* L. [1,49–51]. There are also some plants that seem to reduce milk production when consumed in large amount: *Salvia officinalis* L. (sage), *Vaccinium myrtillus* L. (bilberry), *Petroselinum crispum* (Mill.) Fuss (parsley), and *Mentha ×piperita* L. (peppermint) [23,39,52].

In Sicily, a West-Mediterranean island, many spontaneous plants are traditionally eaten as vegetable-food or are utilized for their medicinal properties [53–57]. Especially people living in rural villages recognize traditionally galactagogue properties of some spontaneous plants and use them for that purpose. As reported by Pitrè [58], during the postnatal puerperium period (of childbirth and breastfeeding), there are good dishes that improve poor milk secretion, e.g., cooked lettuce, watercress and wild fennel, boiled nettle tops, pasta with endive, and sesame in bread [58]. In Sicily, no specific studies on galactagogue plants have been carried out to date. Some information can be gathered from general works on the use of spontaneous edible plants, such as *Silybum marianum* [56], *Nigella damascena* seeds in Madonie Park [55], *Allium cepa*, *Foeniculum vulgare* subsp. *vulgare*, and *Borago officinalis* in Etna Park [59].

The goal of this study was to: (***i***) identify the wild galactagogue plants and vegetable-food remedies traditionally used by women living in the Madonie area during breastfeeding to increase milk production, and (***ii***) determine the used parts and their mode of preparation.

Material and methods

The area of study

The Madonie mountains are located in the northern part of Sicily. The territory is located between Pollina River to the east and Imera River to the west. The central part of the area is characterized by carbonatic substrates, which give rise to variation in relief that at higher altitudes constitutes the second group of mountains of Sicily (Pizzo Carbonara, 1,979 m). In the Madonie mountains, there are various geological formations dating from the Upper Triassic to the Lower Miocene age [60,61]. The landscape is characterized by calcarenitic and dolomitic rocks with peaks and cliffs, whereas some areas consist of quarzarenitic and silico-clastic rocks (Flysch Numidico). The climate is characterized by cold winters with snowfall and xerothermic summers. The various orographic areas exhibit complex ecological characteristics that result in a wide variety of environments, with numerous habitats giving rise to singular biological and biocenotic expressions. The territory is considered a biodiversity hotspot because of the numerous species and the high level of endemism. In a surface area equal to 1.55% of the entire island, there are 1,700 vascular plant taxa (approximately 55% of the Sicilian flora), among which 170 are endemic. From a biogeographical point of view, the flora is expressed in several groups, including the eastern and southern ones, as well as the Mediterranean element in the Steno and Eurimediterranean expressions [60,61]. The main population centers, which have played an important role in the anthropization and exploitation of the area, are Petralia Sottana, Polizzi Generosa, Geraci Siculo, Isnello, Castelbuono, Collesano, and Petralia Soprana. Other very close centers are Gratteri, Campofelice di Roccella, Cefalù, and Pollina in the north and San Mauro Castelverde, Scillato, Caltavuturo, Sclafani Bagni, Gangi, Blufi, and Castellana Sicula in the south (Fig. 1). The first traces of human presence in the Madonie go back to the Greek expansion in Sicily, whereas the main economic activities started in the Middle Ages. The urban structures and the subdivision of the territories (latifundium) are typical of the feudal age [60,61]. The economy has always been based on agriculture, forest exploitation, and grazing, but because of the ever-increasing anthropization, excessive grazing, deforestation, and summer residence buildings, many ecosystems have been destroyed. To protect these territories, in 1989 the natural regional "Park of Madonie" was established, which covers more than 40,000 hectares of the area [60,61].

Fig. 1 Map of the study area and geographical location of surveyed villages in Sicily.

Field study methods

The field work was carried out in the years 2010–2015 by gathering ethnobotanical information from the inhabitants of 18 rural Sicilian communities, belonging to the Madonie mountain territory in the province of Palermo. Data were obtained by means of a structured questionnaire, which included general questions (name, surname, sex, age, level of education, work experience) and specific ones on wild taxa and some plants that have been cultivated for a long time in Sicily and are traditionally utilized as galactagogues. The questions were concerned with the vernacular names of the vegetables, the parts used, and methods of use. The interviews, frequently conducted in both the Italian and Sicilian dialect, were performed (after prior informed consent) with a stratified, randomly selected sample of 105 local people, divided into three age groups: 60–80, 40–59, and 20–39 years. For each age-group consisting of 35 people, we selected 25 women (18 housewives, five farmers, two teachers) and 10 men (four shepherds, four farmers, two specialists in ethnic traditions) because the topic concerns women, although men are usually the experts concerning folk plants. The identification of the most common taxa was carried out in the field. Plant samples were usually collected together with the interviewees, during or after the interview, and we confirmed the correct identification of the plants. Alternatively, specimens were collected and identified in the laboratory according to *Flora d'Italia* and more recent taxonomic revisions [62]. Voucher specimens of the plants were collected and deposited in the Herbarium of Francesco Minà Palumbo Museum (Castelbuono-Palermo, Sicily).

Nomenclature follows the Sicilian checklists [63,64] and the standards set by The Plant List database [65]. The biological forms and chorological data of the investigated taxa were also reported [64]. The study was carried out following The Code of Ethics of the International Society of Ethnobiology [66].

Data analysis

We compared the data gathered during the field study to other ethnobotanical investigations dealing with this subject, and to national and international ethnobotanical literature sources and popular references that considered the traditional uses of wild plants in local cuisines for galactagogue purposes [1,12,23,28–32,39,49–52]. The data obtained (frequency of mention, usage of the parts of the plants, and methods of preparation) were evaluated using the cross-table analysis tool in Microsoft Excel software.

Results

Ethnobotanical investigation revealed a total of 34 species, belonging to 11 families and 25 genera, used by local people for galactagogue purposes. The reported taxa are listed in Tab. 1 including their scientific and Sicilian vernacular names, information concerning their life forms, their geographical distribution areas (chorotype), their parts used, their methods of preparation, and their relative phytochemical profiles according to the literature. The most represented family was Asteraceae, with 12 genera and 17 species, whereas the Urticaceae family included only one genus with four species (i.e., *U. dioica*, *U. membranacea*, *U. urens*, and *U. pilulifera*), which are sometimes collected indifferently. Most of the listed species are spontaneous, but some traditionally cultivated species were also reported, including *Cichorium endivia*, *Lactuca sativa*, *Avena sativa*, *Medicago sativa*, *Trifolium pratense*, and *Trigonella foenum-graecum*. Concerning the biological spectrum (Fig. 2), the majority of galactagogue species belonged to the hemicryptophytes (53%), followed by terophytes (44%). The analysis of the chorological spectrum (Fig. 3) showed that the Eurimediterranean and Stenomediterranean elements were the most represented (18% and 15%, respectively).

Lactuca sativa and *L. serriola* were the most cited taxa (100% frequency), mentioned by all three age categories of interviewed people (Fig. 4 and Tab. 1), whereas *Cichorium endivia*, *Foeniculum vulgare* Mill. subsp. *vulgare*, and *Sonchus* spp. (*S. asper*, *S. oleraceus*, and *S. tenerrimus*) were known as galactagogue species by 100% of the informants from the 60–80 age group. *Silybum marianum*, *Cichorium intybus*, *Borago officinalis*, *Urtica* spp., *Nasturtium officinale*, and *Taraxacum officinale* were largely known as galactagogues among the oldest interviewed people (Fig. 4 and Tab. 1). *Nasturtium officinale* was the only semiaquatic wild plant cited as a galactagogue by all three age

Tab. 1 List of the galactogogue plants used in the Madonie territory.

Family/species	Vernacular name	Life forms	Chorotype	Parts used	Methods of preparation	Phytochemical profile	Age group 60–80; % (*n*)	Age group 40–59; % (*n*)	Age group 20–39; % (*n*)
Apiaceae									
Foeniculum vulgare Mill. subsp. *vulgare*	Finucchieddru sarvaggiu	H scap.	S-Euromedit.	Seeds, fresh leaves	Infusion, boiled vegetables, flavoring	Essential oils (anethole, estragole, fenchone, α-pinene, limonene, camphene phellandrene), flavonoids, phenols, oxalic acid, high content of ascorbic acid and vitamin C, high amount of K, ω-3 fatty acids [5]	100 (35)	100 (35)	91 (32)
Asteraceae									
Centaurea calcitrapa L.	Apròcchiri picucara, sciaccablisci	H bienn.	Eurimedit.	Fresh leaves	Boiled vegetables	β-caryophyllene, 6,10,14-trimethyl-2-pentadecanone, *n*(Z)-β-farnesene, heptanal [5]	31 (11)	23 (8)	21 (7)
Cichorium endivia L.	Nirvia	T scap.	Cultiv.	Fresh leaves	Boiled vegetables or raw in salad	Flavonoid conjugates: kaempferol 3-*O*-glucuronide, kaempferol 3-*O*-(6-*O*-malonyl)-glucoside, kaempferol 3-*O*-glucoside and kaempferol 3-*O*-rhamnoside [18] amino acids, ascorbic acid, folacin, riboflavin, vitamin B6, vitamin B1 and PP, minerals (Ca, Cu, Fe, Mg, Mn, Mb, P, Na), α-linoleic acid, oleic acid, palmitc acid, panthotenic acid, stearic acid, β-carotene, fat, fiber, carbohydrates, phenolics [17]	100 (35)	97 (34)	94 (33)
Cichorium intybus L. var. *intybus*	Cicòria, cicòira	H scap.	Paleotemp.	Fresh leaves dried root	Boiled vegetables or raw in salad	Bitter compounds lactucin and lactucopicrin (latex); α-linolenic acid, apigenin, astragalin, β-carotene, betain, caffeic acid, tannins, chlorogenic acid, bitter glycoside cichoriin, coumarin, ferulic acid, inulin, kaempferol, PUFA, quercetin, rutin, taraxasterol, vanillic acid, flavonoids, carotenoids phenolics, mucilages, essential oil, cichoresic acid esculetol-7-glucoside; lactucin-likeguaianolides, phenols, stigmasterol, γ-sitosterol [5]	91 (32)	86 (30)	86 (30)
Crepis vesicaria L. subsp. *vesicaria*	Cicoria missinìsa, cicoria amara	T scap.	Euro-Medit.-Subatl.	Fresh leaves	Boiled vegetables	Sesquiterpene lactones luteolin, luteolin-7-glucoside phenols [5]	31 (11)	20 (7)	9 (3)
Hyoseris radiata L.	Attalebbra, erba duci	T ros.	Stenomedit.	Fresh leaves	Boiled vegetables	Phenols [5]	29 (10)	23 (8)	11 (4)

Tab. 1 Continued

Family/species	Vernacular name	Life forms	Chorotype	Parts used	Methods of preparation	Phytochemical profile	Age group 60–80; % (*n*)	Age group 40–59; % (*n*)	Age group 20–39; % (*n*)
Hypochaeris achyrophorus L.	Costa ri vecchia, cicoria lingua di jatta	T scap.	Stenomedit.	Fresh leaves	Boiled vegetables or raw in salad	Isoetin derivates: isoetin 7,β-D-glucopyranoside-2′-β-D-xylopyranoside, isoetin 7,β-D-glucopyranoside-2′-β-D-(4″-acetylxylopyranoside) luteolin 7-diglucoside [20]	23 (17)	20 (11)	9 (4)
Hypochaeris radicata L.	Cicoria furfuciata, sgàrri	H ros.	Europ-Caucas.	Fresh leaves	Boiled vegetables	Guaiane derivatives, germacranolides, eudesmane derivatives, isoetin (leaves), phenolics, flavonoids [5]	49 (17)	31 (11)	11 (4)
Lactuca sativa L.	Lattùca	H bienn.	Cultiv.	Fresh leaves	Boiled vegetables or raw in salad	Glycosides, steroids, phenolics, tannins, resin, lactucarium, oxalic, malic and citric acid, quercetin conjugates, luteolin-7-*O*-glucuronide and cyanidin conjugates in the red-leaved varieties [18], ascorbic acid; minerals (Na, K, Mg, Fe, Cu, Cl, Z, P); vitamins (A, B1, B2, C, E, K, G, nicotinic acid, folic acid); seeds: lactucarium, hyosciamine, fatty acids (palmatic, stearic, arachidic, oleic, linoleic and caproic acid); leaves: starch, sugar, gum, cellulose, lignose, fat, Ca, P, I, florine, vit. B1, B2, PP, and carotene; root: glycosides (lactoside A, lactoside C, macro-cliniside A) [3]	100 (35)	100 (35)	100 (35)
Lactuca serriola L.	Lattuca arbaggia, lattùca spinusa	H bienn.	S-Europ.-Southsib.	Fresh leaves	Boiled vegetables	Latex with lactucon, lactucin, lactucic acids [5]	100 (35)	100 (35)	100 (35)
Reichardia picroides (L.) Roth.	Caccialiepru, curcita	H scap.	Stenomedit.	Fresh leaves	Boiled vegetables	Flavonoids, cinnamic derivatives, polyphenols, isoetin (leaves) [5]	89 (31)	77 (27)	57 (20)
Silybum marianum (L.) Gaertner	Cardug-giu, cardu marianu	H bienn.	Euro-Medit.-Turan.	Fresh or dried leaves infiorescence	Boiled vegetables, infusion	Apigenin, β-carotene, fumaric acid, kaempferol, naringenin, quercetin, silandrin, silymarin comprising silybin, silychristin, silydianin; silymonin, taxifolin, tyramin, histamine minerals (Ca), oxalic acid [5]	94 (33)	83 (29)	77 (27)

Tab. 1 Continued

Family/species	Vernacular name	Life forms	Chorotype	Parts used	Methods of preparation	Phytochemical profile	Age group 60–80; % (*n*)	Age group 40–59; % (*n*)	Age group 20–39; % (*n*)
Sonchus asper (L.) Hill subsp. *asper*	Cardedda spinusa, cardedda di scecchi	T scap.	Eurasiat.	Fresh leaves	Boiled vegetables	Sesquiterpene lactones, taraxasterol, lacticino-similar compounds, guaianolide; *Sonchus oleraceus*: phenols, flavonoids, campesterol, stigmasterol, γ-sitosterol, phenols; *Sonchus* spp.: ω-3 fatty acids, vitamin C, carotenoids, flavonols, phenolics, proantho-cyanidins; soluble oxalate; minerals (Ca), isoetin [5]	100 (35)	86 (30)	86 (30)
Sonchus oleraceus L.	Cardedda bianca, cardedda fimminina	T scap.	Eurasiat.	Fresh leaves	Boiled vegetables		100 (35)	86 (30)	86 (30)
Sonchus tenerrimus L.	Cardedda di muru, cardèdda scucìvola	T scap.	Stenomedit.	Fresh leaves	Boiled vegetables		100 (35)	86 (30)	86 (30)
Taraxacum officinale Weber	Tarassacu, denti di liuni	H ros.	Circumbor.	Dried or fresh whole plant (root, leaves, flowers)	Boiled vegetables, infusion	Bitter compound lattupicrin, tannins, inulin, resin, taraxerol, taraxasterol, pseudotaraxasterol, ß-amirin (latex of the stem and root), flavonoids, tetraidroridentin B, taraxicolyde-β-*O*-glycoside, taraxicoside, taraxasterol, sitosterol, stigmasterol, β-amirin; fibers, linolenic acid, β-carotene, β-sitosterol, caffeic acid, cryptoxanthin, lutein, *p*-coumaric acid, saponin, stigmasterol, high content of K, carotenoids, vitamins, proteins, choline, inulin, pectin, taraxacerin [5]	71 (25)	51 (18)	31 (11)
Tragopogon porrifolius L. subsp. *porrifolius*	Latti d'aceddi, barbabecchi	H bienn.	Eurimedit.	Fresh leaves	Boiled vegetables, infusion	Flavonoids, phenolic compounds [5]	31 (11)	23 (8)	9 (3)
Urospermum dalechampii (L.) F. W. Schmidt	Cicoria sarvaggia, cuosti i porci	H scap.	Eurimedit.	Fresh leaves	Boiled vegetables	Germacranolides, dihydroflavonol-3-*O*-methyl-taxifolin, quercetin aglycone, melampolide, guaianolide zaluzanin, mucilage, phenolic compounds, oils [5]	20 (7)	11 (4)	0
Boraginaceae									
Borago officinalis L.	Vurrania, burraina	T scap.	Eurimedit.	Whole plant	Boiled vegetables	Mucilage, allantoin, potassium nitrate, resins, tannins, several sterols, pyrrolizidine alkaloids, procyanidin, phenolic acids, flavonoids, minerals (P) [5]	89 (31)	86 (30)	66 (23)

Tab. 1 Continued

Family/species	Vernacular name	Life forms	Chorotype	Parts used	Methods of preparation	Phytochemical profile	Age group 60–80; % (*n*)	Age group 40–59; % (*n*)	Age group 20–39; % (*n*)
Brassicacae									
Nasturtium officinale R. Br.	Crisciuni, scavùni	H scap.	Cosmop.	Whole plant (leaves and thin stems)	Boiled vegetables	Glucosinolates (converted in isothiocyanates, particularly glyconasturtosides from which derives phenethyl isothiocyanate), β-carotene, tryptophan, tyrosine myristicin, α-terpinolene, flavonoids, gluconasturtiin (the precursor of 2-phenylethyl isothiocyanate), caffeic acid, quercetin and quercetin derivates (quercetin-3-*O*-rutinoside isorhamnetin), caftaric acid and derivates, coumaric acid and derivates, vitamins (A, C, B1, and niacin), and mineral salts (Fe, Ca, Na, K, P) [5,25]	74 (26)	63 (22)	49 (17)
Fabaceae									
Medicago sativa L. subsp. *sativa*	Erva merica	H scap.	Eurasiat.	Fresh leaves shoots	Raw in salad	Alkaloids (stachydrine, 1-homostachydrine), coumesterol, flavonoids, isoflavonoids, carotenoids, phenolic acids, minerals (Fe, Ca, K, P and Zn) [23]	20 (7)	11 (4)	5 (2)
Trifolium pratense L. subsp. *pratense*	Trifuogghiu	H scap.	Eurosib.	Aerial parts of the flowering plant	Infusion	Isoflavones (biochanin A, daidzein, formononetin, genistein, pratensein, trifoside), flavonoids (pectolinarin, trifolin, isoquercitrin), clovamides, L-dopa–caffeic acid conjugates, coumarins (coumestrol, medicagol, coumarin), galactomannan, resins, minerals and vitamins, and phytoalexins [23]	51 (18)	40 (14)	43 (15)
Trigonella foenum-graecum L.	Fenu grecu, triunieddra	T scap.	SW Asia	Seeds	Infusion	Elemene, selinene, furanone, dihydrobenzofuran, muurolene, dihydroactinidiolide, alkaloids (trigonelline, gentianine, carpaine), saponins (diosgenin, yamogenin, gitogenin, tigogenin), flavonoids (vitexin, isovitexin, orientin, vicenins, quercetin, luteolin), and galactomannan [23]	40 (14)	20 (7)	31 (11)

Tab. 1 Continued

Family/species	Vernacular name	Life forms	Chorotype	Parts used	Methods of preparation	Phytochemical profile	Age group 60–80; % (*n*)	Age group 40–59; % (*n*)	Age group 20–39; % (*n*)
					Malvaceae				
Althaea hirsuta L	Marvavisca, vastuni di San Giuseppe	T scap.	Eurimedit.	Root	Decoction	*Althaea* spp.: isoquercitrin, glycosides (roots and stem) [17].	23 (8)	11 (4)	5 (2)
Althaea officinalis L.	Erva piscia-voi, marvavisca	H scap.	SE-Europ.	Root	Decoction	D-Glucan, diosmetin glucosides, flavanoids (kaempferol, quercitin), polyphenolic acids (syringic, caffeic, salicyclic, vanillic), pectin, asparagine and tannins [23]	11 (4)	9 (3)	5 (2)
					Poaceae				
Avena sativa L.	Avena, jina	T scap.	Cultiv.	Seeds	Boiled or crushed seeds	Minerals (Ca, Na, Mg, Fe, Cl, P, K, Cu, Mn), vitamin B1, B2, B5, B6, K1, E, and PP, carotene, essential amino acids, lipids, saponins (avenacosides A-B), sterols, flavonoids, flavolignans, triterpenoid, β-glucan, proteins (gluten), alkaloids (gramine and avenine) [3,9]	69 (24)	80 (28)	60 (21)
					Ranunculaceae				
Nigella damascena L.	Vaccareddi, lampiuneddi	T scap.	Eurimedit.	Seeds	Infusion	Phenols (thymol, thymoquinol, thymoquinone, gentisic acid), alkaloids (damascenine, nigellamine, magnoflorine), flavonoids (kaempferol, quercetin), saponins (hederagenin) [19]; fatty acids (palmitc, stearic, oleic acid, linoleic and α-linoleci acid, eicosanoic and eicosadienoic acid), tocopherols (α-T, γ-T, β-T, and δ-tocotrienol), sterols (campesterol, stigmasterol, β-sitosterol, 5-avenasterol, 7-avenasterol) [8]	40 (14)	25 (9)	5 (2)
					Rosaceae				
Rubus idaeus L.	Amureddu di San Franciscu	H scap.	Stenomedit.	Fresh or dried leaves, fruits	Leaves as infusion, fresh fruit	Polypeptides, flavonoids, glycosides of kaempferol and quercetin, tannins, pectin, fructose, volatile oil, citric acid, malic acid, vitamin (A, B complex, C, E), and minerals (Fe, Ca, K, P, N, Mg, S, B, Cu, Mn, Zn); fruit: anthocyanins, carotenoids, β-carotene, and licopene [14,23]	52 (18)	40 (14)	26 (9)

Tab. 1 Continued

Family/species	Vernacular name	Life forms	Chorotype	Parts used	Methods of preparation	Phytochemical profile	Age group 60–80; % (*n*)	Age group 40–59; % (*n*)	Age group 20–39; % (*n*)
Urticaceae									
Urtica spp.[1]							77 (27)	65 (23)	54 (19)
Urtica dioica L.	Ardìcula fimminedda, lardìca sarvaggia	H scap.	Subcosmop.	Fresh leaves	Boiled vegetables sauces,	Quercetin, kaempferol, isorhamnetin-3-*O*-glycoside, lignans, flavonoids, polysaccharides, lectins, steroids mineral salts; β-carotene, betaine; acetic, caffeic and ferulic acids; lecithin, lycopene, *p*-coumaric acid, scopoletin, caffeic acid derivative compounds, ceramides, minerals, phytosterols, glycosides, phytosterols, saponins, flavonoids, tannins, amino acids, vitamin K and folate (primarily 5-methyltetrahydrofolate) rutin; kaempferol and resveratrol in some nettle samples, serotonin, histamine, acetilcholin, 5-idrossitriptamin, salicilic acid, minerals, nitrates (leaves) [5]			
Urtica membranacea Poir.	Addrìcula, ziculièdda	T scap.	S-Steno-medit.	Fresh leaves	Boiled vegetables, sauces	Monoterpenes: limonene, linaool, cineol; polyphenols: (hydroxycinnamic acid) [4]; flavonoids (i.e., leucoanthocyanins), tannins (gallic acid), sterols [4]			
Urtica pilulifera L.	Ardicula masculina	T scap.	S-Steno-medit.	Fresh leaves	Boiled vegetables, sauces	Alcohols (cedrol and lauryl alcohol), aldehydes (octadecanal and citral), ketones (allyl ionone and α-ionone), esters (benzyl *n*-valerate), amide (octadecenamide), terpenes (4-terpeniol and caryophyllene); fatty acids: linoleic, oleic, palmitic and stearic acid; steryl glycosides: β-sitosterol-3-*O*-ᴅ-glucoside, stigmasterol-3-*O*-β-ᴅ-glucoside, stigmasterol-3-*O*-galactoside [24]			
Urtica urens L.	Ardiculèdda fimminedda, ddìcula	T scap.	Subcosmop.	Fresh leaves	Boiled vegetables, sauces	Minerals (Na, Ca, P, Mg, Mn, N, P, Fe, Cu, Zn), crude lipids, crude proteins, and crude fiber, phytate, saponins, flavonoids (leucoanthocyanins, quercetin, proanthocyanidins), ascorbic acid, tannins (gallic acid), sterols, triterpenes, mucilage [4,6]; stinging hairs: histamine, formic acid, acetylcholine, acetic acid, butyric acid, leukotrienes, 5-hydroxytryptamine [6]			

Tab. 1 Continued

Family/species	Vernacular name	Life forms	Chorotype	Parts used	Methods of preparation	Phytochemical profile	Age group 60–80; % (*n*)	Age group 40–59; % (*n*)	Age group 20–39; % (*n*)
					Verbenaceae				
Verbena officinalis L.	Birbina	H scap.	Paleotemp.	Fresh or dried leaves	Infusion	Iridoid glycosides (verbenin, verbenalin, bastatoside), tannin, volatile oils (citral, geraniol, limonene, verbenone), saponins, mucilage and alkaloids [23]	43 (15)	60 (21)	31 (11)
Vitex agnus-castus L.	Làganu, lignu castu, agnucastu.	P caesp.	Euromedit-Turan.	Fresh or dried leaves, fruit	Infusion or fresh fruit	Iridoids (agnoside, aucubin), flavonoids (casticin, kampferol, quercetagetin, vitexin), progesterone, hydroxy-progesterone, testosterone, epi-testosterone, androstenedione, alkaloids (viticin), palmitic, oleic, linoleic acid and stearic acid [23]	54 (19)	37 (13)	23 (8)

Life forms: H bienn. – biennial hemicryptophytes; P caesp. – caespitose phanerophytes; H ros. – rosette hemicryptophytes; T ros. – rosette therophytes; H scap. – scapose hemicryptophytes; T scap. – scapose therophytes. **Chorotype:** Circumbor. – circumboreal; Cosmop. – cosmopolitan; Cultiv. – cultivated; Eurimedit. – Eurimediterranean; Euri-Medit.-Subatl. – Euro-Mediterranean-Subatlantic; Euromedit.-Turan. – Euro-Mediterranean-Turanian; Eurasiat. – Eurasiatic; Europ.-Caucas. – Euro-Caucasian; Eurosib. – Eurosiberian; Paleotemp. – paleotemperate; Stenomedit. – Stenomediterranean; SE-Europ. – South-East-European; S-Euro-Medit. – South-Euro-Mediterranean; S-Europ.-Southsib. – South-European-South-Siberian; S-Stenomedit. – South-Stenomediterranean; SW-Asia – Southwest Asia; Subcosmop. – subcosmopolitan. **Age groups:** % cited species – (*n* respondents).
[1] The age-group columns include the data of *Urtica dioica* L., *U. membranacea* Poir., *U. pilulifera* L., and *U. urens* L.

groups with a frequency ranging between 49% and 77%. *Nigella damascena*, *Tragopogon porrifolius*, and *Crepis vesicaria* were rarely cited, especially by the 20–39 age group, whereas *Urospermum dalechampii* was not mentioned by the youngest interviewed people (Tab. 1). Low frequency of mention was also found for *Althaea hirsuta*, *A. officinalis*, and *Medicago sativa* because they do not occur very frequently; in particular, *Medicago sativa* is uncommonly cultivated in Sicily because of inadequate water resources.

Overall, the mean value for the percentage of taxa mentioned by women ranged between 45.4% (20–39 age group) and 62.6% (60–80 age group), whereas for men it ranged between 52.1% and 79.6% (20–39 and 60–80 age group, respectively).

The most used parts of galactagogue plants were the leaves (69%), mainly eaten as cooked vegetables or raw in salads. The seeds of *Trigonella foenum-graecum*, *Nigella damascena*, *Foeniculum vulgare*. subsp. *vulgare*, and *Avena sativa* were employed as a decoction or infusion, as well as the dried roots of *Althaea officinalis*, *A. hirsuta*, *Cichorium intybus*, and *Taraxacum officinale*. The fresh fruits of *Vitex agnus-castus* and *Rubus idaeus* were utilized. For some species, more than one part or the entire plant was used, i.e., *Foeniculum vulgare*. subsp. *vulgare*, *Cichorium intybus*, *Silybum marianum*, *Taraxacum officinale*, *Borago officinalis*, *Nasturtium officinale*, *Rubus idaeus*, and *Vitex agnus-castus* (Fig. 5A and Tab. 1).

Discussion

As reported by numerous studies [1,23,49–51,56,59], several wild spontaneous plants contain a wide variety of phytochemical substances with potential galactogenic properties (Tab. 1). These plants, consequently, can be used as food remedies to augment milk production in breastfeeding women.

The prevalent mention of the taxa belonging to the Asteraceae family (Fig. 4 and Tab. 1) as being utilized to increase milk production during breastfeeding, as well as for food and a source of vegetable remedies, was because the taxa of this family are rich in secondary metabolites and are the most abundant in the Mediterranean flora, and therefore are easily available to local people. These plants have been gathered and employed for many generations in Sicily for their diversified phytochemical profiles, which enrich the human diet with biologically active molecules [54,67,68]. According to the *Checklist of the vascular flora of*

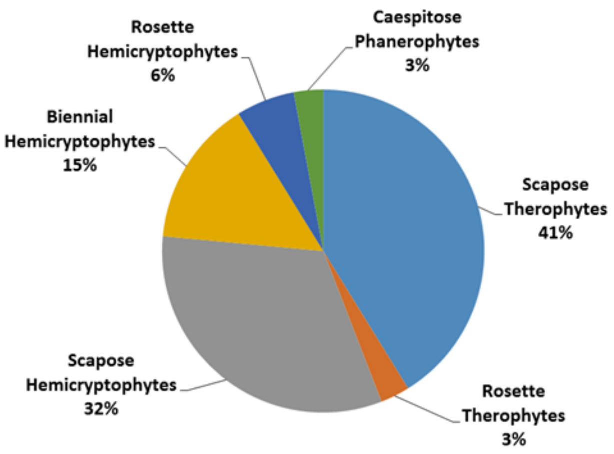

Fig. 2 Biological spectrum of the investigated taxa.

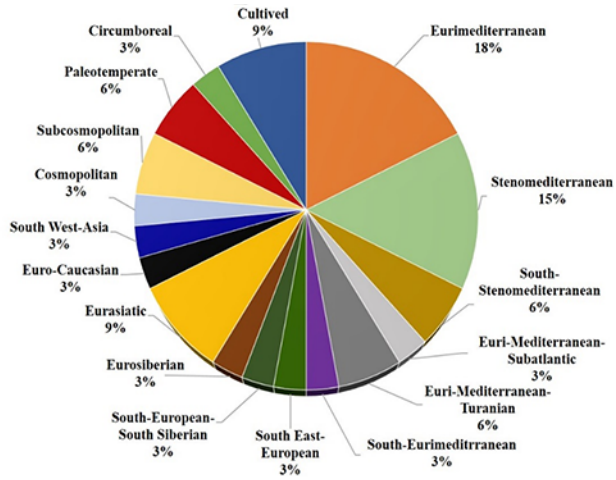

Fig. 3 Chorological spectrum of the investigated taxa.

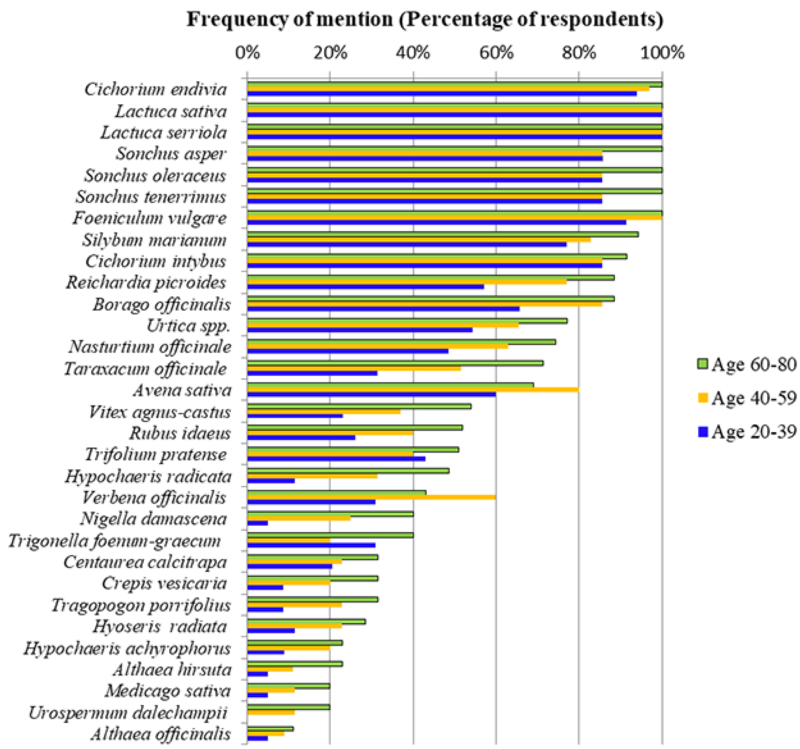

Fig. 4 Frequency of mention of galactagogue taxa.

Sicily, the Asteraceae family occurs in Sicilian flora with 103 genera and 371 specific and infraspecific taxa [64].

Many galactagogues are obtained from plants containing latex, the majority of which belong to the Asteraceae family, such as *Lactuca sativa*, *Cichorium intybus*, *Reichardia picroides*, *Sonchus* spp., *Crepis vesicaria*, *Hypochaeris radicata*, *Taraxacum officinale*, and *Hyoseris radiata* (Tab. 1). This fact recalls the medieval "doctrine of signatures" by Paracelsus, according to which plants possess signs indicating their usage. Though this doctrine cannot be scientifically validated, there are indeed several latex-producing plant species that are stated to be quite efficient in promoting lactation [12].

Some taxa, such as *Lactuca sativa*, *Cichorium endivia*, *Cichorium intybus*, and *Hypochaeris achyrophorus*, are eaten after being boiled, or consumed raw in salads seasoned with oil, salt, and lemon or vinegar or in mixed vegetable soups [54,56]. The leaves of

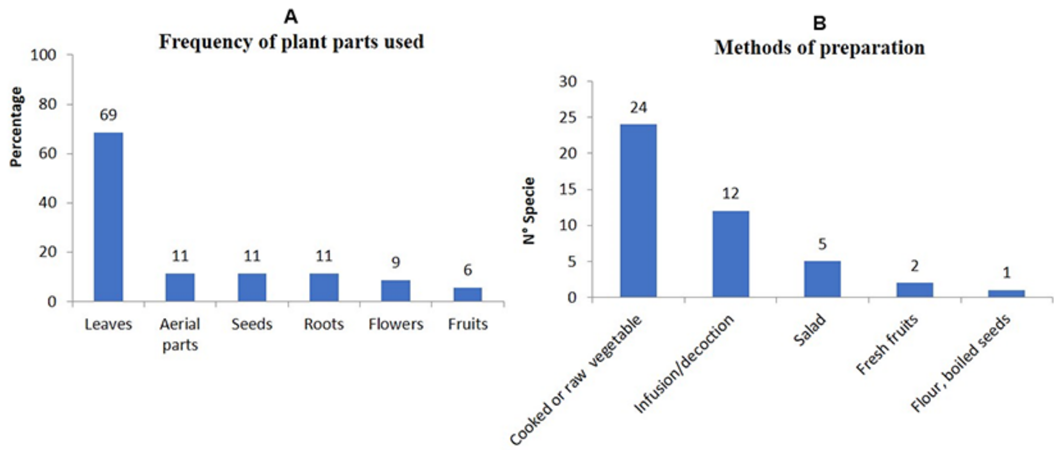

Fig. 5 (**A**) Plant parts used for galactagogue purposes. (**B**) Methods of preparation of galactagogue plants.

Urtica spp. and *Foeniculum vulgare* subsp. *vulgare* are also employed to prepare sauces to flavor local dishes [56]. Alternatively, fresh or dry leaves can be utilized for infusions to increase milk production (Tab. 1 and Fig. 5B).

The seeds are generally employed to prepare tea infusions. The seeds of *Foeniculum vulgare* subsp. *vulgare*, containing anethole and estragole phytoestrogens, are also an ingredient for seasoning many traditional Sicilian dishes [47]. Moreover, these seeds, beyond their galactagogue properties, are used in Sicily to prepare infusions for soothing colic in infants through breastfeeding [49].

Traditionally in Sicily, *Silybum marianum* is utilized as food and a galactagogue remedy (Tab. 1 and Fig. 5): leaves, young shoots, inflorescences, and stems are eaten raw in salads or boiled, or powdered dried leaves are consumed as an infusion [54,68]. Previous studies conducted on humans and animals suggested that this species has positive effects on milk secretion because it contains a mixture of flavonolignans. Silybin, the major constituent of silymarin, binds to cytosolic estrogen receptors determining phytoestrogenic activity [48,69,70].

Rubus idaeus and *Vitex agnus-castus* are the only two species cited by local people regarding the consumption of fresh fruits to increase milk production (Fig. 5). The active principles of làganu (*Vitex agnus-castus*) consist in a combination of iridoids (aucubin and agnusid), flavonoids (casticin, kampferol, quercetagetin, vitexin), and volatile oils (Tab. 1). *Rubus idaeus* (amureddu di San Franciscu) produces sweet and flavorful red fruits, which contain high levels of bioactive compounds (Tab. 1), such as anthocyanins, vitamins, carotenoids, phenols, and minerals. However, in both cases, there are not scientific studies confirming their direct effects on breastfeeding [12], but their use may have positive implications for women's and newborns' overall health.

Nasturtium officinale (crisciuni) is a perennial leafy plant that grows in rivulets, ditches, and pond margins. Its leaves have a spicy but pleasing taste and they can be eaten as a fresh salad vegetable [54,56], but it is recommended that women during breastfeeding consume them boiled to avoid the risk of *Fasciola hepatica* infection. The nutraceutical use of their leaves is caused by the significant content of glucosinolates and breakdown products (isothiocyanates, nitriles, and thiocyanates), pigments (carotenoids and chlorophylls), phenolics compounds (coumaric acid, caftaric acid, and quercetin, among others), vitamins (A, B1, niacin, and C), and mineral salts (Fe, Ca, P, Na, and K). The presence of various phytochemicals and their nutritional benefits give *Nasturtium officinale* the capacity of maintaining and improving immunity and health of the body [71]. Despite the lack of scientific evidence confirming its galactogenic characteristics, the consumption of watercress by women during breastfeeding can be an alternative source of nutrients (in particular mineral salts and vitamins) useful to the improvement of milk secretion.

Elderly men and women (age group 60–80) resulted the best connoisseurs of traditional plant uses. Among men, in particular, shepherds possessed the widest knowledge of galactagogue plants because of their indirect experience through animals; moreover, young shepherds maintain the oral knowledge handed down by family members. It is noteworthy that men in Sicily usually pay particular attention to their wives during the breastfeeding period, and they know and collect the useful plants to help them provide a good source of milk for their newborns.

Among women, housewives and farmers knew the plants used to increase milk production during breastfeeding either directly or on the basis of the tradition. Nevertheless, this information declines as generations pass (as appreciable in Tab. 1). Women having the highest education level often indirectly knew the uses of plants through the experience of their mothers and grandmothers.

Conclusions

This work represents a first contribution to the knowledge of the plants traditionally used in the Madonie area to increase milk production in women and to improve their and their newborns' wellbeing. A balanced diet, rich in nutritional benefits, together with a healthy lifestyle is the main factor for good production of breast milk. The galactagogue plants can provide valuable support, although it is crucial to know that some of their active constituents may cause side effects in both mothers and their infants. This fact argues for increased public awareness and for available information on the safety implications of using herbal medicines to be provided at least among breastfeeding women [38]. The species cited in this study are mainly vegetables commonly utilized by local populations with high nutritional profiles, which can improve the quality and quantity of milk produced by mothers. Their use has been supported by centuries of experience, but it is not confirmed by scientific evidence that would definitely show their action and effectiveness. Lactation represents a particularly delicate phase in women's lives, because it rests on hormonal, neural, and psychological factors. According to Jelliffe and Jelliffe [72], differences in benefits suggest that in some cases, the effectiveness of the employment of wild vegetable galactagogues may derive from the consolidate belief that they will work well. This enables the mother to relax and facilitates the stimulation of the milk-let-down reflex [72].

The interviews carried out in this study in the Madonie area showed that older people are a precious source of information for the younger generations. Therefore, they represent a significant resource to enhance the cultural identity of the territory with the valorization and rediscovery of the wild-vegetable heritage before the traditions disappear permanently. It would be desirable to perform new research on characterization, quantification, and the mechanism of action of the active principles contained in these galactagogue wild plants to link their traditional uses to future applications.

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