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# Ethnobotany of purslane (*Portulaca oleracea* L.) in Italy and morphobiometric analyses of seeds from archaeological sites in the Emilia Romagna Region (Northern Italy)

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## Riassunto

Il presente lavoro, dopo un breve quadro tassonomico di *Portulaca oleracea* L., fornisce una sintesi delle informazioni etnobotaniche sulla specie in Italia e i risultati delle analisi morfobiometriche su semi di porcellana rinvenuti in diversi siti archeologici (dal Periodo Romano all'Evo Moderno) in Emilia Romagna (Nord Italia); queste analisi tendono a rilevare la presenza/assenza nel tempo delle due sottospecie *P. oleracea* subsp. *oleracea* (forma spontanea) e *P. oleracea* subsp. *sativa* (forma coltivata), per meglio comprendere il rapporto uomo/porcellana nel corso dei secoli.

*Portulaca oleracea* L., purslane, was well known in the classical world for its multiple uses. Purslane produces capsules containing several small seeds invested by a robust integument; they are usually well preserved and frequently occur in archaeological sites in the Emilia Romagna Region, since the Bronze Age (Monte Leoni, Parma - Ammerman *et al.* 1976): their identification does not leave any doubt, due to their particular morphology (Beijerinck 1947; Berggren 1981; Cappers *et al.* 2006; Davis 1993; Delorit 1970; Martin and Barkley 2000; Schoch *et al.* 1988; Viggiani and Angelini 2002). Purslane is currently considered very interesting from a food point of view (van Wyk 2005), so much that it is included in the list of "World Economic Plants" (Wiersema and León 1999). The National Institute of Rural Sociology comprises *Portulaca oleracea* within the category of "regional herbs" of the Emilia Romagna Region (Picchi and Pieroni 2005) and it is cultivated as a medicinal plant in the Garden of Casola Valsenio (Ravenna) (Ferrari 1987). Archaeological-ethnobotanical implications of this plant can be demonstrated furnishing an exact meaning to the presence of its seeds in archaeological deposits: are these the documentation that *Portulaca* was a synanthropic plant or that it was a plant precultivated/cultivated by man?

## Purslane: taxonomical description

*Portulaca oleracea* L. (Portulacaceae) is a cosmopolitan species (Danin and Reyes-Betancourt 2006), whose status of native of Italy is doubtful (Pignatti 1982). The following botanical forms are

recognised: a) four subspecies/species growing spontaneously; b) another subspecies growing spontaneously (invasive – weeds – in irrigated cultures, and ruderal in inhabited areas), i.e. *P. oleracea* subsp. *oleracea* (= *P. oleracea* var. *sylvestris* DC.), with a prone form (fig. 1); c) a cultivated subspecies (often growing in wilds) i.e. *P. oleracea* subsp. *sativa* (Haw.) Celak., with a suberect form and ascending stems (fig. 2) (Pignatti 1982; Ricciari and Arrigoni 2000; Walters 1993). The site of origin is not known for a certainty and several temperate areas of the Northern Hemisphere are proposed (Haudricourt and Hedin 1993): Eurasia, in particular Southern Europe (Walters 1993), Europe, Western Asia, China (Schoch *et al.* 1988), India, but also sub-desert areas of Northern Africa, which could explain the succulent aspect of the plant (Holm *et al.* 1977). A similar uncertain regards the place and the time in which the domestication of purslane occurred: it seems originated in the Western Himalayan area, then spreaded towards the South of Russia and Greece, perhaps as far back as 4,000 years ago (De Candolle 1883), due to the nutritional value of the plant and also its adaptability to hostile environments (Holm *et al.* 1977; Bois 1927).

*P. oleracea* subsp. *oleracea* and *P. oleracea* subsp. *sativa* are distinguished by several vegetative and floral characteristics (Pignatti 1982; Salah and Chemli 2004; Walters 1993), while the ornamentations of the seeds are identical with differences in size, although modest. The ornamentations are determined by rounded tubercles arranged in a row, in a regular pattern, with scarce papillae. The size of the seeds is larger in subsp. *sativa* (average size 1.2 mm;  $\pm 0.07$  S.D.) with respect to subsp. *oleracea* (average sizes 0.86-0.87 mm;  $\pm 0.03$  to 0.06 mm S.D.), depending on the populations (Danin *et al.*



1. - Wild purslane (Mattioli 1568).



2. - Cultivated purslane (Mattioli 1568).

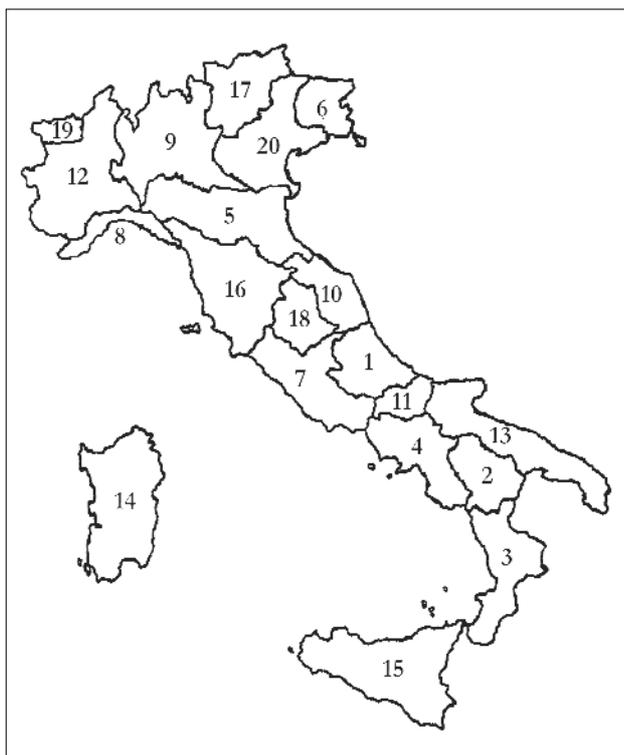
1978; Ricciari and Arrigoni 2000). Other biometric data (again concerning fresh seeds, generically attributed to *Portulaca oleracea*) are accompanied by descriptions that seem to indicate either one or the other subspecies: the sizes reported by Delorit (1970) and by Davis (1993), respectively 0.6-0.9 and 0.7-0.8 mm, could be referred to subsp. *oleracea*, while those of Schoch *et al.* (1988) seem to include the cultivated subspecies (0.7-1.1 mm). In relation to the morphobiometry of the seeds, Danin *et al.* (1978) affirm that subsp. *sativa* developed in the Old World through anthropic selection (Ricciari and Arrigoni 2000) from subsp. *oleracea*, the most common in Eurasia (Zohary 1973). Subsp. *sativa* could, therefore, be considered a landrace or a “form” of the other subspecies (Danin *et al.* 1978; Thulin 1993). Salah and Chemli (2004) studied the phenotypic variability of several Tunisian populations of *Portulaca oleracea* subsp. *sylvestris* and of *P. oleracea* subsp. *sativa*, taking in consideration many morphological characters and hypothesizing that the detected differences were due to better and more stable growth conditions of the cultivated plants. The species is practically ubiquitary, endowed with great morpho-cito-physiologic plasticity (Matthews *et al.* 1993; Zimmerman 1976), and it is not very demanding from edaphic and hydric points of view. It shows a rapid growth (Bois 1927) and feature

mechanisms that facilitate its propagation, making it a weed hardly eliminable. Purslane prefers a fertile, rich, sandy soil (Häflinger and Brun-Holl 1981), but also settle for poor, arid soil. This adaptability has led it to success and popularity since ancient times.

To evaluate the quantitative significance of *Portulaca* seeds in archaeological strata, it is useful to remember that seed production of these plants is very high (one plant can introduce up to 10,000 seeds to the environment (Holm *et al.* 1977) and the productivity is similar in the two subspecies (Salah and Chemli 2004).

#### **Purslane: etymology, historical notes, and ethnobotanical situation in Italy**

In the Linneian binomial, *Portulaca* derives from the Latin, *portula* = little door, perhaps from the type of dehiscence of the fruit (*pyxidium* - Spijnt 1994), while *olera* = vegetable, indicates the diffuse use as food of this species in the Classical World (Gallino 2001). Proof of the multiple uses and the wide geographic spread of purslane lies in the variety of common names attributed to it, with differences in word roots, according to the various linguistic stocks from which they derive (Hernández Bermejo and León 1994). The common



3. - Italian Regions (see list dialectal names of purslane).

Italian name, “*porcellana*”, is also different from the Italian dialectal names that derive from the Latin term used by Pliny (1<sup>st</sup> cent. A.D.), *porcilaca*, perhaps due to its meaning: an “herb liked by pigs”, with the root, *lac* = milk, which seems underline the mucilagenous content found in the plant. The variety of common names corresponds to the vast range of uses to which it has been destined by man in the past.

#### *Several dialectal names from various Regions of Italy* (fig. 3)

**1. Abruzzo:** *porcacchia, precacchia* (Penzig 1924) *priccachiune grasse, pricacchie* (Tammaro 1984), *percacchie, porcacchie, precacchie* (Manzi 1999); **2. Basilicata:** *perchiacca* (Penzig 1924); **3. Calabria:** *porcillana, purciddana, porcejane, andraca, andrachi* (Penzig 1924); **4. Campania:** *porchiacca, perchiacchella, purchiacchello, porcellana, chiaccunella* (Penzig 1924), *erva vasciulella* (De Feo *et al.* 1991), *purchiacchella* (De Feo *et al.* 1992); **5. Emilia Romagna:** *erba grassa, purzlana, porzlana* (Penzig 1924); **6. Friuli-Venezia Giulia:** *gràssule* (Penzig 1924); **7. Lazio:** *purchiacchia, porcacchia, pircacchia, percacchie, erba grassa* (Guarrera 1994); **8. Liguria:** *purselana, erba purselana, porsellanna, persulaua, porselana, erba gnànoa* (Penzig 1924); **9. Lombardy:** *porselana, porselaga, erba grassa* (Penzig 1924); **10. Marche:** *porcinacchia, sportelacchia* (Penzig 1924) *pulcinacchia, purcinacchia* (Guarrera 1990); **11. Molise:** *porcacchia, precacchia* (Penzig 1924); **12.**

**Piedmont:** *porslana, purslane* (Penzig 1924), *pourslana, pourseslane* (Mattiolo 1918), *puirsclana, pursclanna, pursclenna, purslana, purslòna, biun, èrba grasa, èrba dal purchèt/di purchit, èrba purcatèra, èrba purchétera* (Sella 1992); **13. Puglia:** *pricchiuzzi* (Penzig 1924); **14. Sardinia:** *porzelana, barzellana, porceddana, pulsallana* (Penzig 1924); **15. Sicily:** *gamaruneddu marinu, purciddana, purciaca, prucciaca* (Penzig 1924), *burdulaca, cucciara, pirciddana, pucciddana, puccillana* (Lentini and Venza 2007); **16. Tuscany:** *porcellana, erba porcellana, sportellacchia, porcacchia, procaccia, procacchia, andracne, erba da porci, erba grassa, erba porcacchia* (Penzig 1924); **17. Trentino Alto Adige:** *porzelàne* (Dalla Fior 1969); **18. Umbria:** *procacchia, porcacchia (in verbis)*; **19. Aosta Valley/;** **20. Veneto:** *porcellana salbèga* (Penzig 1924).

#### *Active ingredients and known properties*

All the parts of this plant have medicinal properties: from the roots to the stem, from the leaves to the seeds (Bois 1927; Gastaldo 1987; Lieutaghi 1992). According to Duke (2002), the purslane plant has very important effects in the medicinal field (approximately 30 different biological activities and over 60 medicinal indications concerning the plant), and he considers it a “medicinal food” to consume like spinach. *Portulaca oleracea* contains betanidin-5-0-allobioside, isobetanidin-5-0-allobioside, ferulic acid, betacyanin acylate (Imperato 1975). Gastaldo (1987) and Schauenberg and Paris (1977) report the presence of quercetin, quercitrin, sitosterin glucoside, oleracin, campherol, cyanidin, dopamine, noradrenalin, oxalic acid, calcium oxalate, and sugars. Tammaro (1984) also cites saponin, mucilage, and Vitamin C. Caneva *et al.* (1998) recognize in this plant proteins, fatty acids, aspartic acid, glutamic acid, citric acid, and oxalic acid, as well as fair amounts of Vitamins A, B6, and C, potassium, magnesium, sodium, and sulphur. Purslane has also been discovered to be rich in omega-3 type polyunsaturated fatty acids (Ezekwe *et al.* 1999) and, for this reason, it was introduced in the diet of US citizens, in order to counteract the intake of fatty acids derived from fast foods (Picchi and Pieroni 2005).

#### *Purslane in treatments*

Because of its medicinal properties, Purslane is mentioned by Dioscorides (1<sup>st</sup> cent. A.D.) with the name *andracne*, also used by Pliny (1<sup>st</sup> cent. A.D.) (Massonio 1627). More specifically, Pliny, who considered it a veritable panacea, describes the plant in Book 20 of the *Naturalis Historia*, dedicated to the benefits of vegetables in medicine. Classical authors attributed to purslane analgesic, anti-inflammatory, diuretic, emol-

lient, soothing, anti-fever, vermifugal, and anaphrodisiac properties, often citing its mucilaginous content. These plant's therapeutic uses continue to be found during the Middle Ages and during the Renaissance period (for ex. Hildegard - 12<sup>th</sup> cent.; Mattioli - 16<sup>th</sup> cent.), often accompanied by esoteric implications (Cattabiani 1996), linking the plant to magical proprieties (Cunningham 1992). The use of purslane was also disparaged by someone, like Hildegard of Bingen (*Physica*, LXXIV) and Michele Savonarola, a physician from Padua (Italy) from the 15<sup>th</sup> cent. A.D. (*Libreto de tutte le cose che se manzano comunemente* - "Book of all the things that are commonly eaten"), while Castore Durante (*Herbario*, LVIII) recommended its use, but in a moderate manner (Ballerini 2008). English physician Nicholas Culpeper (17<sup>th</sup> cent. A.D.) believed the seeds to be more effective than the leaves (Ballerini 2008) and, at times, to have cosmetic properties (for example using the leaves to brush the teeth: Sella 1992). It was also used in veterinary medicine. In the 18<sup>th</sup> century, the juice of the plant, mixed with red roses, was given to horses as a fever treatment (Atzei 2003). Many of the properties attributed to purslane in the past have subsequently been confirmed, attested by modern phytochemical studies. The plant's properties include: muscle relaxant, anti-convulsive, analgesic, and anti-inflammatory, with also a potential anti-anxiety effect (Chan *et al.* 2000; Radhakrishnan *et al.* 2001). Recently, the content of bioactive catecholamine, noradrenalin, and dopamine in *Portulaca oleracea* was investigated and, in the light of these recent studies, the expression "plant of long life" attributed to purslane in Chinese tradition, seems to be actually appropriate (Chen *et al.* 2003).

#### *Uses in popular medicine in Italian Regions*

For the Friuli Region, Appi *et al.* (1979) mention the diuretic properties of the herb in soups with leeks and nettles, while Coassini Lokar and Poldini (1988) report the diuretic effect of its decoction. In the Lazio Region, skin rashes and pimples or boils were cured with compresses obtained by purslane infusions, and the herb was also eaten to cure reddened gums (Guarrera 1994). In the Abruzzo Region, the leaves were applied to the forehead and temples to relieve headaches (Tammaro 1984). In the Campania Region, the infusion was known for its vermifugal properties and, poultices obtained by decoction were applied to the stomach to treat gastric acid (De Feo *et al.* 1991). Many uses were indicated in the Sardinia Region: the juice from the leaves was deemed useful for urinary inflammations and the infusion is still believed to be a diuretic. The herb was considered a treatment for scurvy in the 18<sup>th</sup> cent. A.D. and was eaten raw as an analgesic for gastric, intestinal and kidney pain, or it was cooked and eaten as a cure for

worms, haemorrhoids and haemoptysis. The juice was drunk as a fever remedy and an anaphrodisiac. Deemed vulnerable during the 18<sup>th</sup> cent. A.D., it was chewed to cure mouth and gum ulcers, as well as toothaches. It was also used to calm eye inflammations and St. Anthony's Fire, as an analgesic for headaches, bladder pains, raspy voice, and was also known as a foot corn remedy (Atzei 2003). An infusion of its seeds and leaves was drunk in case of dysentery and urogenital infections, while compresses were used for eye inflammations and the fresh leaves were applied with corn flour to wounds to prevent gangrene (Ballero and Fresu 1993).

#### *Purslane as food*

Both subspecies are edible (all parts of the whole plant, including the seeds, can be used), and have similar comestible characteristics, usable both for humans (van Wyk 2005) and for animals (in particular, it is given to pigs, which eat it avidly: Atzei 2003; Sella 1992; Guarrera *et al.* 2004; at Sassari-Sardinia, it is given to rabbits: Atzei 2003; while the seeds, at Tolfa-Lazio, are used as bird feed: Guarrera 1994). The herb, which is tossed in a pan with garlic and oil, has a taste that resembles pork meat (Picchi and Pieroni 2005). According to different classical authors, it was one of the leafy vegetables (from both spontaneous plants, as well as cultivated ones) eaten in Italy during the 1<sup>st</sup> cent. A.D. (Pitrat and Foury 2003). Varrone praised its dietary virtues (Arcidiacono and Pavone 1994). Pliny also discussed purslane in Book 19 of *Naturalis Historia*, which deals with vegetable gardening: «There are plants that must be sown together: poppies with cabbage and purslane, arugula with lettuce». The context and citation is in line with its status of horticultural plant. Columella (1<sup>st</sup> cent. A.D.), in Book 12 of *De Re Rustica*, indicates a recipe for preserving purslane (the plant was picked in autumn, then cleaned and put in the shade to dry. After four days, it was then stored in jars, whose bases were covered with a layer of salt on top of which the purslane was placed, after which vinegar and more salt were added). The recipe, enriched with verjuice and fennel, was also used for the same purpose and used during the 1500's in France (Ducomet 1917), since the species does not dry out and cannot be desiccated. The use of purslane as food, specifically a leafy vegetable, is known throughout the Middle Ages (it was cultivated in monasteries - Arcidiacono and Pavone 1994) and it strongly developed from the 13<sup>th</sup> cent. until the beginning of the 19<sup>th</sup> cent. A.D. (Ducomet 1917; Pitrat and Foury 2003). In the past, it was a very useful food for ship crews, who often suffered from scurvy (Lentini and Venza 2007). In Italy, purslane was sold as a common vegetable in the markets: Francesco Balducci Pegolotti (14<sup>th</sup> cent. A.D.), a travelling merchant from Florence, included it in the list of products sold by

Italian merchants. Purslane was, above all, used as a cooked or raw vegetable (Castelvetro 1614; De Rougemont 1990), and its seeds were used as condiments/aromas, as those of the *Papaver somniferum* L. The young leaves and stems, when raw, have a very strong flavour, hence the tradition of using them with other types of greens or for flavouring olives, capers, sauces, and soups. Also Castelvetro (16<sup>th</sup> cent. A.D.), in his *Breve racconto di tutte le radici di tutte l'erbe e di tutti i frutti che crudi o cotti in Italia si mangiano* ("Brief stories of all the roots of the all herbs and of all the fruits that are eaten, raw or cooked, in Italy"), states that the purslane plant was used in salads, either alone or with other greens, and recommends it be served with finely chopped onions and pepper, to take the 'edge' off the plant. Costanzo Felici (16<sup>th</sup> cent. A.D.), a physician and naturalist, author of a treatise on edible plants, reports that the herb was often eaten in salads with basil, onions, cucumbers, and other vegetables. The plants growing in vegetable gardens, develop large leaves and branches, unlike from those of the wild plants, which were much smaller. Even at the beginning of the twentieth century, it was still "universally used in salads" and was also good when "eaten cooked, like spinach" (Mattirolo 1918) and for its mucilaginous consistency was used in thickening soups and stews (Luciano *et al.* 2008). In various parts of Italy, it was also eaten deep fried in oil, or in a batter made from flour, eggs, and bread crumbs, sautéed in a pan, or boiled. It can also be preserved in vinegar, like capers, and the more succulent stems, if cut up, can be pickled (Arcidiacono and Pavone 1994). No true market for this plant exists today, in Italy, although it is considered an horticultural plant (Bianco and Pimpini 1990), except in some locality in Central Italy (Picchi and Pieroni 2005). It is, instead, sold in France, the largest producer of its horticultural forms (Arcidiacono and Pavone 1994), in Spain, and in other Mediterranean basin countries, as well as in India, Eastern Asia, Mexico and, just recently, in the US (Palaniswamy *et al.* 2001).

As previously said, the use of purslane in human diet is attributable to more than one reason: the plant is rich in minerals, proteins, carbohydrates, beta carotene, and Vitamins E and C. (Hernández Bermejo and León 1992; Guil *et al.* 1997; Turan *et al.* 2003). In particular, Turan *et al.* (2003) include purslane among those edible leaf species with a greater variety of proteins, N, K, Ca, and Mg than other, more common, vegetables, such as spinach, lettuce, and cabbage. However, among leafy garden vegetables, its main quality is that is the richest in omega-3 fatty acids and antioxidants (Ezekwe *et al.* 1999; Liu *et al.* 2000; Palaniswamy *et al.* 2001), therefore, better than traditional grown vegetables (Liu *et al.* 2000). In fact, these factors are well-known for

reducing the epidemiologic levels of cardiovascular illnesses and neoplasia. It might not be by chance that minor incidences of these serious symptomologies have been registered in countries in the Mediterranean area (Greece and Lebanon), where the consumption of *Portulaca* is more common (Ezekwe *et al.* 1999). Recent studies have compared several cultivar of *P. subsp. sativa* with geographically different populations of *P. subsp. oleracea*, maintained in controlled conditions. However, the results demonstrated that, whether wild or cultivated, purslane has the rare capacity to increase essential fatty acids, with a process that is not yet well known (Ezekwe *et al.* 1999).

### *Use in foods in Italian Regions*

In the Piedmont Region, this plant was eaten in salads, cooked (like spinach), but believed best eaten with oil and vinegar. Since it has a delayed vegetation period, purslane did not appear in spring salads (Mattirolo 1918); Sella (1992) refers to the use of its leaves and leafy stems, picked before the plant blossomed, in salads or soups, and that the herb was not liked by everyone due to its moist, sticky consistency. In the Friuli Region, the boiled leaves were kept in oil, garnished with chopped garlic, anchovies, and breadcrumbs, then cooked *au gratin* (Appi *et al.* 1979). In the Marche Region, it is still eaten in mixed salads (Guarrera 1990). On the coast of Ancona, several restaurants decorate fish dishes with the herb or use it as a side dish (Picchi and Pieroni 2005). In the Lazio Region, it is added to salads, because of the refreshing and diuretic proprieties it is attributed. In Ciociaria, it is often used in salads with anchovies (Guarrera 1994). In the Abruzzo Region, the leafy tops are eaten in salads (Tammaro 1984). Manzi (1999) noted that in vegetable gardens, it was cultivated up to the 19<sup>th</sup> cent. A.D. In the Campania Region, the herb – used in salads – was known as an excellent diuretic and bland laxative (De Feo *et al.* 1992). Also in the Basilicata Region, Caneva *et al.* (1998) report the use of the raw tender leaves in mixed salads, which give it a typical, slightly sour flavour, but they warn that the presence of oxalic acid could make its use toxic if eaten in large amounts. In the Sardinia Region, the leaves are eaten in mixed salads with vinegar, cooked, or pickled (Atzei 2003). In the Calabria Region, in the Crotonese area, it is common to pickle the aerial parts of this plant with methods that resemble those indicated by Columella (Picchi and Pieroni 2005). In Sicily, cooked use of this plant is often mentioned (Picchi and Pieroni 2005), while Lentini and Venza (2007) report the use of this tender plant in salads with tomatoes, capers, and cucumbers or as a delicious ingredient in soups. In Bronte, plants without signs of blooming (not even a bulb or fructification) are deemed excellent to eat in

salads with oil, vinegar, and salt (Arcidiacono *et al.* 2003). On Etna, the use of young unbloomed tops is not very common, due to their salty flavour and unappetising mucilaginous consistency, which could nevertheless be used to thicken broths (Arcidiacono and Pavone 1994).

#### *Purslane: particular properties*

Currently, while on the one hand, *Portulaca oleracea* could be considered a fastidious, invasive species in cultivated environments, on the other, it is important in natural wastewater management, because of its resistance to salinity and its capacity to purify (Grieve and Suarez 1997).

From the mucilaginous content of its stems and leaves, already cited by classical authors, a gum (POG) can now be extracted. This gum does not have a viscose consistency, it is soluble in water, and stable emulsions can be obtained from it. The results suggest various possibilities for the use of POG in food, pharmaceutical, and industrial preparations (Garti *et al.* 1999).

#### **Purslane in the Emilia Romagna Region through archaeobotanical data**

In archaeological sites in the Emilia Romagna Region, *Portulaca oleracea* seeds are frequent archeobotanical findings in various types of deposits ranging from the Roman Period to the Modern Age (Bosi and Bandini Mazzanti 2007). As already mentioned, it is extremely interesting to establish whether these findings can be attributed to synanthropic plants or plants that were picked and/or grown by man for food or curative purposes.

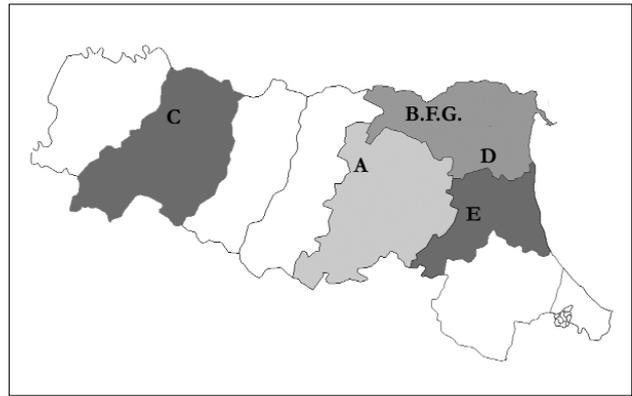
#### **Morphobiometric analysis of the seeds**

The morphological analysis were performed with a Wild M10 stereomicroscope (up to 100x magnification) and a Nikon Digital Sight DS-5M (NIS - Element f 2.20). Images of the findings were acquired with ImageJ and the measurements of the largest diameter of intact, non-combusted seeds were obtained (*sensu* Danin *et al.* 1978).

The morphological characteristics of the tegument of the *Portulaca* seeds are similar in all layers, in all periods, and are ascribed to *P. oleracea* subsp. *oleracea* and *P. oleracea* subsp. *sativa* (*sensu* Danin *et al.* 1978).

#### **Roman Period**

Due to the scarce number of seeds per site, these findings were not measured (Bosi and Bandini Mazzanti 2007).



4. - Archaeobotanical records of purslane in the Emilia Romagna Region; sites of Medieval and Renaissance Periods.

#### **Medieval and Renaissance Periods**

Seeds from 11 contexts were analysed and measured, dated from the 10<sup>th</sup> and 16<sup>th</sup> cent. A.D., ascribable to 7 sites (fig. 4), with the rule of a maximum of 50 seeds per layer applied for measurement purposes.

**A - S. Agata (Bologna)** - Nuova Geovis - inhabited defensive ditches - outdoors (2 layers) (10<sup>th</sup>-11<sup>th</sup> cent. A.D.) (Bosi *et al.* in press)

**B.1 - Ferrara** - corso Porta Reno/via Vaspergolo - suburban vegetable garden rubbish dumps - outdoors (6 layers) (second half 10<sup>th</sup>-first half 11<sup>th</sup> cent. A.D.) (Bosi 2000; Bosi *et al.* in *litteris*)

**B.2 - Ferrara** - corso Porta Reno/via Vaspergolo - craft industry area garbage dump - outdoors (3 layers) (second half 11<sup>th</sup>-first half 12<sup>th</sup> cent. A.D.) (Bosi 2000)

**C - Parma** - Piazza Repubblica - city market area rubbish dumps - outdoors (2 layers) (12<sup>th</sup>-13<sup>th</sup> cent. A.D.) (Bosi *et al.* 2002, in *litteris*)

**D.1 - Argenta (Ferrara)** - via Vinarola/Aleotti - requalified canal - outdoors (6 layers) (1275 - 1325 A.D.) (Bandini Mazzanti *et al.* 1999)

**B.3 - Ferrara** - corso Porta Reno/via Vaspergolo - urban centre rubbish dump - outdoors (2 layers) (end 14<sup>th</sup>-beginning 15<sup>th</sup> cent. A.D.) (Bosi 2000)

**B.4 - Ferrara** - corso Porta Reno/via Vaspergolo - stone tub for waste (housing area) - indoors (4 layers) (mid-14<sup>th</sup>-end 15<sup>th</sup> cent. A.D.) (Bandini Mazzanti *et al.* 2005)

**E - Lugo (Ravenna)** - Piazza Baracca - stone tub for waste (craft industry area) - indoors (1 layer) (15<sup>th</sup> cent. A.D.) (Bosi *et al.* in *litteris*)

**F - Ferrara** - Piazza Municipale - stone tub for waste from the Ducal Palace - indoors (1 layer) (second half 15<sup>th</sup> cent. A.D.) (Bosi *et al.* 2009)

**G - Ferrara** - Monastery of S. Antonio - contents of a mug - indoors (1 layer) (15<sup>th</sup>-16<sup>th</sup> cent. A.D.) (Bandini Mazzanti *et al.* 2006; Romagnoli *et al.* 2007)

**D.2 - Argenta (Ferrara)** - via Vinarola/Aleotti - latrine from the Monastery of S. Caterina - indoors - (2 layers) (16<sup>th</sup> cent. A.D.) (Mercuri *et al.* 1999)

site	A	B.1	B.2	C	D.1	B.3	B.4	E	F	G	D.2	
outdoor/indoor	outdoor	outdoor	outdoor	outdoor	outdoor	outdoor	indoor	indoor	indoor	indoor	indoor	
chronology	10 <sup>th</sup> -11 <sup>th</sup> cent.	second half 10 <sup>th</sup> - first half 11 <sup>th</sup> cent.	second half 11 <sup>th</sup> - first half 12 <sup>th</sup> cent.	12 <sup>th</sup> -13 <sup>th</sup> cent.	1275-1325	end 14 <sup>th</sup> - beginning 15 <sup>th</sup> cent.	half 14 <sup>th</sup> - end 15 <sup>th</sup> cent.	15 <sup>th</sup> cent.	second half 15 <sup>th</sup> cent.	15 <sup>th</sup> -16 <sup>th</sup> cent.	16 <sup>th</sup> cent.	
measured seeds	14	219	116	74	14	76	107	50	50	12	27	
<= 0,93	<i>Portulaca oleracea</i> L. subsp. <i>oleracea</i>	50	39	58	43	50	28	34	4	28	75	41
0,94 - 1,12	intermediate size	50	61	42	57	50	72	64	90	70	25	59
>= 1,13	<i>Portulaca oleracea</i> L. subsp. <i>sativa</i>	\	\	\	\	\	\	2	6	2	\	\

Tab. 1 - *Portulaca oleracea*: percentages of the seeds according to their size and chronological phase.



5. - *Portulaca oleracea* subsp. *sativa* - seed (d. max 1.24 mm - from site E) (photo by R. Rinaldi).

## Results and discussion

### Roman Period

Direct and indirect proof shows that the few Roman seeds found do not attest to precultivation/cultivation, nor to use (even though this would have been compatible with historic/literary sources), but are random documentations of the purslane weed in urban and cultivated environments (Bosi and Bandini Mazzanti 2007).

### Medieval and Renaissance Periods

The results are shown in tab.1 where, for every class of size (created on the basis of data by Danin *et al.* 1978), the frequent percentage of the seeds was indicated. One photo of a seed appears in fig. 5.

### Early Middle Ages

In the three contexts, all outdoors (A, B.1 and B.2), the size of the seeds does not indicate *P. oleracea* subsp. *sativa*, and we cannot exclude that the purslane plant was already used by man for food purposes. This could be true, especially for B.1, given the high percentage of seeds with intermediate sizes within the framework of the garden suburban zone.

### Late Middle Ages

In the two contexts, both outdoors (C and D.1), the situation remains practically unchanged, with respect to the previous historical period. It is, however, interesting

to underline that in site C (city market area garbage dump, in the historical centre of Parma), along with the seeds, *Portulaca* pollen was also found, which would prove, with certainty, the presence of these plants *in loco* (given the scarce pollen productivity of the species and the large size of the entomophilous pollen, a rare finding in palynological analysis, and very localized (Bosi *et al.* 2002 and *in litteris*).

### Between the Late Middle Ages and the Renaissance

During this transitional stage, there are almost two contemporaneous contexts from the same site in Ferrara centre city, one outdoors (B.3) and one indoors (B.4). In the latter, a waste tub for domestic waste pertaining to the home of a middle-upper class family from Ferrara (Bandini Mazzanti *et al.* 2005), there is probably the first proof of the cultivated form of *Portulaca oleracea*.

### From the Renaissance to the Modern Era

Among the four contexts (E, F, G and D.2), all indoors, two (E and F) demonstrate the presence of subsp. *sativa*, which reaches the highest percentage in E. In the two most recent contexts (G and D.2), the new cultivated form disappears: the mug, from the Benedictine Monastery of S. Antonio in Polesine (G), in the historical centre of Ferrara, has a very poor floristic content (5 taxa), limited to medicinal species, suggesting a therapeutic use of the purslane plant (Bandini Mazzanti *et al.* 2006; Romagnoli *et al.* 2007).

Seeds with a size located in the intermediate interval between the two subspecies were already present in the Early Middle Ages, in percentages similar and often higher than those of the unquestionably spontaneous form. This situation also persists in the Late Middle Ages. Seeds of a size compatible with subsp. *sativa* appear later on, between the 14<sup>th</sup> and 15<sup>th</sup> cent. A.D., in closed urban deposits. Based on data by Danin *et al.* (1978), we should conclude that, for the Emilia Romagna Region, proofs of the presence of *P. oleracea* subsp. *sativa* begin in the 15<sup>th</sup> cent. A.D., in co-existence with *P. oleracea* subsp. *oleracea*. However, several circumstances must be considered: a) the measurements

taken by Danin *et al.* (1978) are referred to fresh seeds, while we are concerned with sub-fossil seeds, without embryo and endosperm or with very little residues of them, which have undergone stress of various natures caused by the time they remained in the deposit environment and the procedures adopted during the extraction process; b) the chronological interval between the current seeds and the younger sub-fossils seeds is approximately 500 years (the seeds are comprised between approximately 1,000 and 500 years from the present). It cannot be excluded that anthropic selection continued to influence a plastic species like the *Portulaca oleracea* over the last five centuries, stabilising an increase in seed size in the cultivated "form". It could therefore be assumed that the seeds pertaining to the intermediate interval also indicate the cultivated form, or at least, plants on the way to becoming it.

## Conclusions

The archaeobotanical findings show the possible growth of the purslane plant in the Emilia Romagna Region, from the Roman Period to the threshold of the Modern Era. During the Early Middle Ages, in contrast with the Roman Period, purslane seems to have taken on the role of a plant that looked after man rather than that of an invasive weed. During the Late Middle Ages, and the first stages of the Modern Era, the purslane plant was almost certainly a plant that was cultivated in gardens, vegetable/fruit gardens, and vegetable gardens in suburban and urban areas. Probably, the presence of subsp. *sativa* can be attested in the 15<sup>th</sup> cent. A.D., even though it cannot be excluded, given the high percentages of the intermediate form, that the cultivated plants were also present previously. The good/abundant presence of *Portulaca* seeds in compartments set up as domestic rubbish dumps sustains its use in human diets, as a vegetable or as a condiment/aroma. The findings of the mug from the Benedictine Monastery of S. Antonio in Polesine, in Ferrara city centre's old town, also appear to attest its medicinal uses.

The archaeobotanical research can gainfully accompany written and iconographic sources, furnishing accurate, comparable data and, above all, tangible and objective proof, through the seed/fruit remains, which may also be useful for locally reconstructing the history of the human/plant relationship.

## References

- Ammerman *et al.* 1976:** A. Ammerman, J. Butler, G. Diamond, P. Menozzi, J. Pals, J. Sevink, A. Smit and A. Voorrips - *Rapporti sugli scavi a Monte Leoni: un insediamento dell'Età del Bronzo in Val Parma*, in *Preistoria Alpina. Museo Tridentino di Scienze Naturali*, 12, 1976, p. 127-154.
- Appi *et al.* 1979:** E. Appi, R. Appi, A. Pagnucco and D. Pagnucco - *Le piante nell'uso popolare in Friuli: terapia e cucina*, Pordenone, Edizioni Concordia Sette, 1979.
- Arcidiacono *et al.* 2003:** S. Arcidiacono, M. Napoli and P. Pavone - *Piante selvatiche d'uso popolare nel territorio di Bronte (Catania)*, in *Quaderni di Botanica Ambientale e Applicata*, 14, 2003, p. 151-172.
- Arcidiacono and Pavone 1994:** S. Arcidiacono and P. Pavone - *Erbe spontanee commestibili del territorio etneo*, in *Bollettino Accademia Gioenia Scienze Naturali*, 27, 346, 1994, p. 461-588.
- Atzei 2003:** A.D. Atzei - *Le piante nella tradizione popolare della Sardegna*, Sassari, C. Delfino, 2003.
- Balducci Pegolotti 1936:** F. Balducci Pegolotti - *La pratica della mercatura*, Cambridge, Allan Evans, 1936 (14<sup>th</sup> cent. A.D.).
- Ballerini 2008:** L. Ballerini - *Erbe da mangiare*, Milano, Mondadori, 2008.
- Ballero and Fresu 1993:** M. Ballero and I. Fresu - *Le piante di uso officinale nella Barbagia di Seui (Sardegna Centrale)*, in *Fitoterapia*, 2, 1993, p. 141-150.
- Bandini Mazzanti *et al.* 1999:** M. Bandini Mazzanti, A.M. Mercuri, G. Trevisan Grandi, M. Barbi and C.A. Accorsi - *Il fossato di Argenta (Ferrara) e la sua bonifica in età medievale: contributo alla ricostruzione della storia del sito in base ai semi e frutti del riempimento*, in C. Guarnieri (Ed.) - *Il Tardo Medioevo ad Argenta: lo scavo di via Vinarola-Aleotti*, Firenze, Edizioni All'Insegna del Giglio, 1999, p. 219-237 (Quaderni di Archeologia dell'Emilia Romagna, 2).
- Bandini Mazzanti *et al.* 2005:** M. Bandini Mazzanti, G. Bosi, A.M. Mercuri, C.A. Accorsi and C. Guarnieri - *Plant use in a city in Northern Italy during the Late Medieval and Renaissance periods: results of the Archaeobotanical Investigation of 'The Mirror Pit' (14th - 15th century A.D.) in Ferrara*, in *Vegetation History and Archaeobotany*, 14 (4), 2005, p. 442-452.
- Bandini Mazzanti *et al.* 2006:** M. Bandini Mazzanti, G. Bosi and C. Romagnoli - *Semi e frutti in boccali del monastero benedettino di S. Antonio in Polesine: indizi di antiche preparazioni officinali?*, in C. Guarnieri (Ed.) - *Il Tardo Medioevo ad Argenta: lo scavo di via Vinarola-Aleotti*, Firenze, Edizioni All'Insegna del Giglio, 1999, p. 301-308 (Quaderni di Archeologia dell'Emilia Romagna, 2).
- Beijerinck 1947:** W. Beijerinck - *Zadenatlas der Nederlandse Flora*, Wageningen, H. Veenman & Zonen, 1947.
- Berggren 1981:** G. Berggren - *Atlas of seeds. Part 3*, Stockholm, Swedish Museum of Natural History, 1981.
- Bianco and Pimpini 1990:** V. Bianco and F. Pimpini - *Orticoltura*, Bologna, Patron, 1990.
- Bois 1927:** D. Bois - *Les plantes alimentaires chez tous les peuples et à travers les ages*, Paris, Paul Lechevalier Editeur, 1927.
- Bosi 2000:** G. Bosi - *Flora e ambiente vegetale a Ferrara*

- tra il X e il XV secolo attraverso i reperti carpologici dello scavo di corso Porta Reno - via Vaspergolo nell'attuale centro storico, Doctoral Thesis, Università degli Studi di Firenze, 2000.
- Bosi et al. 2002:** G. Bosi, M. Bandini Mazzanti, A.M. Mercuri and C.A. Accorsi - *Semi e frutti rinvenuti in buche medievali a Parma*, in *Atti 97° Congresso SBI, 24-27 settembre 2002*, Lecce, Edizioni del Grifo, 2002, p. 203.
- Bosi and Bandini Mazzanti 2007:** G. Bosi and M. Bandini Mazzanti - *Portulaca oleracea L., fra il Periodo Romano e il Rinascimento in Emilia Romagna: informazioni dai reperti archeocarpologici*, in *Inf. Botanico*, 38 (suppl. 1), 2007 (2006), p. 40-47.
- Bosi et al. 2009:** G. Bosi, A.M. Mercuri, C. Guarnieri and M. Bandini Mazzanti - *Luxury food and ornamental plants at the 15<sup>th</sup> cent. AD Renaissance Court of the Este family (Ferrara, Northern Italy)*, in *Vegetation History and Archaeobotany*, 18 (5), 2009, p. 389-402.
- Bosi et al. in press:** G. Bosi, M. Marchesini, S. Marvelli and M. Bandini Mazzanti - *L'alimentazione e l'ambiente vegetale dell'insediamento altomedievale di Sant'Agata Bolognese in base alle analisi carpologiche: dati preliminari*, in S. Gelichi and N. Giordani (Eds.) - *Vivere nel Medioevo*, Firenze, All'Insegna del Giglio, in press.
- Caneva et al. 1998:** G. Caneva, M.A. Pontrandolfi and S. Fascetti - *Le piante alimentari spontanee della Basilicata*, Potenza, Regione Basilicata, 1998.
- Cappers et al. 2006:** R.T.J. Cappers, R.M. Bekker and J.E.A. Jans - *Digitale Zadenatlas van Nederland*, Groningen, Barkhuis Publishing & Groningen University Library, 2006.
- Castelvetro 1614:** G. Castelvetro - *Brieve racconto di tutte le radici di tutte le erbe e di tutti i frutti che crudi o cotti in Italia si mangiano*, Mantova, Gianluigi Arcari Editore, 1988 (1614).
- Cattabiani 1996:** A. Cattabiani - *Florario*, Milano, Arnoldo Mondadori Editore, 1996.
- Chan et al. 2000:** K. Chan, M.W. Islam, M. Kamil, R. Radhakrishnan, M.N.H. Zakaria, M. Habibulah and A. Attas - *The analgesic and anti-inflammatory effects of Portulaca oleracea L. subsp. sativa (Haw) Celak*, in *Journal of Ethnopharmacology*, 73, 2000, p. 445-451.
- Chen et al. 2003:** J. Chen, Y.P. Shi and J.Y. Liu - *Determination of noradrenaline and dopamine in Chinese herbal extract from Portulaca oleracea L. by high-performance liquid chromatography*, in *Journal of Chromatography A*, 1033, 2003, p. 127-132.
- Coassini Lokar and Poldini 1988:** L. Coassini Lokar and L. Poldini - *Herbal remedies in the traditional medicine of the Venezia Giulia region (North East Italy)*, in *Journal of Ethnopharmacology*, 22, 1988, p. 231-278.
- Columella 1977:** Columella - *L'arte dell'agricoltura e Libro sugli alberi*, transl by R. Calzecchi Onesti, Torino, Einaudi, 1977.
- Cunningham 1992:** S. Cunningham - *Enciclopedia delle erbe magiche*, Milano, Mursia, 1992.
- Dalla Fior 1969:** G. Dalla Fior - *La nostra flora. Guida alla conoscenza della flora del Trentino-Alto Adige*, Trento, Casa Editrice G.B. Monauini, 1969.
- Danin et al. 1978:** A. Danin, I. Baker and H.G. Baker - *Cytogeography and Taxonomy of the Portulaca oleracea L. polyploid complex*, in *Israel Journal of Botany*, 27, 1978, p. 171-211.
- Danin and Reyes-Betancourt 2006:** A. Danin and J.A. Reyes-Betancourt - *The status of Portulaca oleracea L. in Tenerife, The Canary Islands, in Lagascalia*, 26, 2006, p. 71-81.
- Davis 1993:** L.W. Davis - *Weed seeds of the Great Plains*, Kansas, University Press, 1993.
- De Candolle 1883:** A. De Candolle - *L'origine des plantes cultivées*, Paris, Balilève, 1883.
- De Feo et al. 1991:** V. De Feo, C. Ambrosio and F. Senatore - *Traditional phytotherapy in Caserta province, Campania, Southern Italy*, in *Fitoterapia*, 63, 1991, p. 337-349.
- De Feo et al. 1992:** V. De Feo, R. Aquino, A. Menghini, E. Ramundo and F. Senatore - *Traditional phytotherapy in the Peninsula Sorrentina, Campania, Southern Italy*, in *Journal of Ethnopharmacology*, 36, 1992, p. 113-125.
- De Rougemont 1990:** G. De Rougemont - *Guida delle piante utili*, Padova, Franco Muzzio Editore, 1990.
- Delorit 1970:** R.J. Delorit - *An illustrated taxonomy manual of weed seeds*, Wisconsin, Agronomy Publications, 1970.
- Ducomet 1917:** V. Ducomet - *Les plantes alimentaires de la flore française*, Paris, J.B. Baillière, 1917.
- Duke 2002:** J.A. Duke - *Handbook of Medicinal Herbs*, Boca Raton, CRC Press, 2002.
- Ezekwe et al. 1999:** M.O. Ezekwe, T.R. Omara-Alwala and T. Membrahtu - *Nutritive characterization of purslane accessions as influenced by planting date*, in *Plant Foods for Human Nutrition*, 54, 1999, 183-191.
- Felici 1982:** C. Felici - *Lettere sulle insalate*, Urbino, Accademia Raffaello, 1982 (16<sup>th</sup> cent. A.D.).
- Ferrari 1987:** C. Ferrari (Ed.) - *Le piante officinali del Giardino di Casola Valsenio*, Bologna, Azienda regionale delle foreste dell'Emilia Romagna, 1987.
- Gallino 2001:** B. Gallino - *Aggiornamento Phytoalimurgia Pedemontana*, in O. Mattiolo - *Phytoalimurgia Pedemontana*, Peveragno, Blu Edizioni, 2001, p. 231-232.
- Garti et al. 1999:** N. Garti, Y. Slavin and A. Aserin - *Surface and emulsification properties of a new gum extracted from Portulaca oleracea L.*, in *Food Hydrocolloids*, 13, 1999, p. 145-155.
- Gastaldo 1987:** P. Gastaldo - *Compendio della flora officinale italiana*, Padova, Piccin, 1987.
- Grieve and Suarez 1997:** C.M. Grieve and D.L. Suarez - *Purslane (Portulaca oleracea L.): a halophytic crop for drainage water reuse systems*, in *Plant and Soil*, 192, 1997, p. 277-283.
- Guarrera 1990:** P.M. Guarrera - *Usi tradizionali delle piante in alcune aree marchigiane*, in *Informatore Botanico Italiano*, 22 (3), 1990, p. 155-167.

- Guarrera 1994:** P.M. Guarrera - *Il patrimonio etnobotanico del Lazio*, Tipar, 1994.
- Guarrera et al. 2004:** P.M. Guarrera, G. Forti, S. Mariognoli and G. Gelsomini - *Piante e tradizione popolare ad Acquapendente*, Acquapendente, Regione Lazio, 2004 (Quaderni del Museo del Fiore, 2).
- Guil et al. 1997:** J.L. Guil, I. Rodríguez-García and E. Torija - *Nutritional and toxic factors in selected wild edible plants*, in *Plant Foods for Human Nutrition*, 51, 1997, p. 99-107.
- Häflinger and Brun-Holl 1981:** E. Häflinger and J. Brun-Holl - *Tavole delle malerbe*, Basilea, CIBA-GEIGY Edizioni, 1981.
- Haudricourt and Hedin 1993:** A.G. Haudricourt and L. Hedin - *L'uomo e le piante coltivate*, Palermo, Flaccovio Editore, 1993.
- Hernández Bermejo and León 1992:** J.E. Hernández Bermejo and J. León (Eds.) - *Neglected crops: 1492 from a different perspective*, Cordoba, Botanical Garden, 1992 (FAO Plant Production and Protection Series, 26).
- Holm et al. 1977:** L.G. Holm, D.L. Pluncknett, J.V. Pancho and J.E. Herbrger - *The World's Worst Weeds, Distribution and Biology*, Honolulu, University Press of Hawaii, 1977, p. 609.
- Imperato 1975:** F. Imperato - *Acylated betacyanins of Portulaca oleracea*, in *Phytochemistry*, 14, 1975, p. 2091-2092.
- Kunkel 1984:** G. Kunkel - *Plants for human consumption*, Koenigstein, Koeltz Scientific Books, 1984.
- Lentini and Venza 2007:** F. Lentini and F. Venza - *Wild food plants of popular use in Sicily*, in *Journal Ethnobiology and Ethnomedicine*, 3, 2007, p. 15.
- Lieutaghi 1992:** P. Lieutaghi - *Jardin des savoirs, jardin d'histoire*, Salagon, Les Alpes de Lumière, 1992.
- Liu et al. 2000:** L. Liu, P. Howe, Y.F. Zhou, Z.Q. Xu, C. Hocartn and R. Zhang - *Fatty acids and  $\beta$ -carotene in Australian purslane (Portulaca oleracea) varieties*, in *Journal of Chromatography A*, 893, 2000, p. 207-213.
- Luciano et al. 2008:** R. Luciano, C. Gatti and M.L. Colombo - *Erbe spontanee commestibili*, Boves, arabA-Fenice, 2008.
- Manzi 1999:** A. Manzi - *Le piante alimentari in Abruzzo*, Villamagna (CH), Ed. Tinari, 1999.
- Martin and Barkley 2000:** A.C. Martin and W.D. Barkley - *Seed Identification Manual*, Caldwell, The Blackburn Press, 2000.
- Massonio 1627:** S. Massonio - *Archidipno ovvero dell'insalata e dell'uso di essa*, Milano, Edi.Artes, 1990 (1627).
- Mattews et al. 1993:** J.F. Mattews, D.W. Ketron and S.F. Zane - *The biology and taxonomy of the Portulaca oleracea L. (Portulacaceae) complex in North America*, in *Rhodora*, 95 (882), 1993, p. 166-183.
- Mattioli 1568:** P.A. Mattioli - *I discorsi nelli sei libri di Dioscoride della materia medicinale*, Venezia, Vincenzo Valgrisi, 1568.
- Mattiolo 1918:** O. Mattiolo - *Phytoalimurgia pedemontana*, Peveragno, Blu Edizioni, 2001 (1918).
- Mercuri et al. 1999:** A.M. Mercuri, G. Trevisan Grandi, M. Bandini Mazzanti, M. Barbi and C.A. Accorsi - *I semilfrutti della latrina del Monastero di S. Caterina*, in C. Guarnieri (Ed.) - *Il Tardo Medioevo ad Argenta: lo scavo di via Vinarola-Aleotti*, Firenze, Edizioni All'Insegna del Giglio, 1999, p. 238-245 (Quaderni di Archeologia dell'Emilia Romagna 2).
- Palaniswamy et al. 2001:** U.R. Palaniswamy, R.J. Mcavoy and B.B. Bible - *Stage of Harvest and Polyunsaturated Essential Fatty Acid Concentrations in Purslane (Portulaca oleracea) Leaves*, in *J. Agric. Food Chem.*, 49, 2001, p. 3490-3493.
- Penzig 1924:** P. Penzig - *Flora popolare italiana - I-II*, Genova, Tipo-Litogr. del R. Istituto Sordomuti, 1924.
- Picchi and Pieroni 2005:** G. Picchi and A. Pieroni - *Le Erbe (Atlante dei prodotti tipici)*, Roma, INSOR e AGRA/RAI ERI, 2005.
- Pignatti 1982:** S. Pignatti - *Flora d'Italia - I*, Bologna, Edagricole, 1982.
- Pitrat and Foury 2003:** M. Pitrat and C. Foury (Eds.) - *Histoires de légumes des origines à l'orée du XXI<sup>e</sup> siècle*, Paris, INRA Editions, 2003.
- Pliny 1986:** Plinio - *Storia Naturale - III-IV*, Torino, Einaudi, 1986 (1<sup>st</sup> cent. A.D.).
- Radhakrishnan et al. 2001:** R. Radhakrishnan, M.N.M. Zakaria, M.W. Islam, H.B. Chen, M. Kamil, K. Chan and A. Al-Attas - *Neuropharmacological actions of Portulaca oleracea L. v. sativa (Hawk)*, in *Journal of Ethnopharmacology*, 76, 2001, p. 171-176.
- Ricciari and Arrigoni 2000:** C. Ricciari and P.V. Arrigoni - *L'aggregato di Portulaca oleracea L. (Portulacaceae) in Italia*, in *Parlatorea*, IV, 2000, p. 91-97.
- Romagnoli et al. 2007:** C. Romagnoli, G. Bosi and M. Bandini Mazzanti - *Reperti carpologici in due boccali (Convento benedettino di S. Antonio in Polesine - Ferrara, fine XV-XVI sec. d.C.): possibili documenti di antiche preparazioni officinali*, in *Informatore Botanico Italiano*, 38 (suppl. 1), 2007(2006), p. 25-32.
- Salah and Chemli 2004:** K.B.H. Salah and R. Chemli - *Variabilité phénotypique de quelques populations de Pourpier (Portulaca oleracea L.) en Tunisie*, in *Acta Bot. Gallica*, 151, 2004, p. 111-119.
- Schauenberg and Paris 1977:** P. Schauenberg and F. Paris - *Le piante medicinali*, Roma, Newton Compton, 1977.
- Schoch et al. 1988:** W.H. Schoch, B. Pawlik, F.H. Schavegruber - *Botanische Makroreste*, Berne, Paul Haupt, 1988.
- Scully 1998:** T. Scully - *L'arte della cucina nel Medioevo*, Torino, Piemme, 1998.
- Sella 1992:** A. Sella - *Flora popolare biellese. Nomi dialettali, tradizioni e usi locali*, Collana della Fondazione Sella, Alessandria, Edizioni Dell'Orso, 1992.
- Spjut 1994:** R.W. Spjut - *A systematic treatment of fruit types*, New York, Memoirs of the New York Botanical Garden, 70, 1994.
- Tammaro 1984:** F. Tammaro - *Flora officinale d'Abruzzo*, Chieti, Regione Abruzzo, 1984.
- Thulin 1993:** M. Thulin (Ed.) - *Flora of Somalia - I*, Kew, London, Publication of Royal Botanic Gardens, 1993.

- Turan et al. 2003:** M. Turan, S. Kordali, H. Zengin, A. Dursun and Y. Sezen - *Macro and micro mineral content of some wild edible leaves consumed in Eastern Anatolia*, in *Acta Agricultura Scandinavica Section B - Soil and Plant Science*, 53, 2003, 129-137.
- Van Wyk 2005:** B.E. van Wyk - *Food Plants of the World*, Portland, Timber Press, 2005.
- Viggiani and Angelini 2002:** P. Viggiani and R. Angelini - *Dicotiledoni spontanee e infestanti*, Bologna, Edagricole, 2002.
- Walters 1993:** S.M. Walters - *Portulaca L.*, in T.G. Tutin et al. (Eds.) - *Flora Europaea vol. 1 (2<sup>nd</sup> edition)*, Cambridge, Cambridge University Press, 1993.
- Wiersema and León 1999:** J.H. Wiersema and B. León - *World Economic Plants: a standard reference*, Boca Raton, CRC Press, 1999.
- Zimmerman 1976:** C.A. Zimmerman - *Growth characteristics of weediness in Portulaca oleracea L.*, in *Ecology*, 57, 1976, p. 964-974.
- Zohary 1973:** M. Zohary - *Geobotanical Foundations of the Middle East*, Stuttgart, G. Fischer, 1973, p. 783.