



Wild sweet *Physalis*: promising underutilized minor crops

Rocío Deanna¹ · Tomi Laurinen¹ ·
Peter Poczai¹

Received: 27 January 2026 / Accepted: 7 March 2026 / Published online: 22 March 2026
© The Author(s) 2026

Abstract Global food security challenges are driving renewed interest in neglected and underutilized crops with high nutritional and agronomic potential. The genus *Physalis* includes more than 95 species, yet only *Physalis peruviana* is commercially exploited despite the presence of at least 15 wild sweet *Physalis* (WSP) species traditionally consumed across the American continent. These species represent a rich but underexplored reservoir of morphological, nutritional, and biochemical diversity. Here, we synthesize current knowledge on WSP taxonomy, distribution, fruit morphology, and phytochemical composition to assess their potential as emerging fruit crops. Several species, including *P. pubescens*, *P. pruinosa*, *P. chenopodiifolia*, and *P. grisea*, exhibit favorable traits—large, sweet berries, high antioxidant capacity, and environmental resilience—supporting their suitability for cultivation and market development. However, significant gaps remain for many taxa, underscoring the need for targeted agronomic, nutritional, and breeding research. We advocate that WSPs offer

promising opportunities to diversify food systems, enhance nutrition, and strengthen climate-resilient horticulture.

Keywords Crop domestication · Food system diversification · Nutritional diversity · Solanaceae · Underutilized fruit crops · Wild sweet *Physalis*

Introduction

Identification of new food resources is critical for addressing the challenges of global food security, which are exacerbated by population growth, climate change, and depletion of arable land. The current global population is nearly 7.9 billion people and is expected to reach 9 billion by 2050 (United Nations. Global issues: Population). This growing population requires innovative solutions to meet the increasing demand for sustainable and nutritious food. Accordingly, much interest has been generated in the underutilized/neglected species referred to as ‘Crops for Future’ from various perspectives, such as nutritional value and food security. Importantly, diversifying food sources can reduce the reliance on staple crops that are vulnerable to environmental stressors, thereby enhancing resilience in agricultural systems.

Approximately 20,000 berry-bearing species exist worldwide, around 2000 of which are recognized as edible, demonstrating their broad diversity and potential as a food resource (RBG Kew 2016). The

R. Deanna (✉) · T. Laurinen · P. Poczai
Botany and Mycology Unit, Finnish Museum of Natural History & Department of Organismal and Evolutionary Biology, Faculty of Biological and Environmental Sciences, University of Helsinki, PO Box 7,
00014 Helsinki, Finland
e-mail: rocio.deanna@helsinki.fi

R. Deanna
Museo Botánico de Córdoba (IMBIV-CONICET-UNC),
Vélez Sarsfield 299, 5000 Córdoba, Argentina

Solanaceae family, or nightshades, includes more than 1800 berry-producing species, such as tomato, eggplant, and pepper, which are not traditionally identified as berries due to their savory use (Knapp 2002). However, the broad diversity of wild, sweet edible berries across the nightshades remains largely unstudied. *Physalis peruviana* L., also known as goldenberry (ENG), *ananaskirsebær* (NOR/DAN), *kapkrusbär* (SWE), *karviaiskoiso* (FIN), *földicseresznye* (HUN), or *uchuva* (SPA), has emerged as a notable exception, gaining popularity in gourmet markets, particularly in European/Nordic countries (Fig. 1). Its appeal lies in its bright orange fruit encased in a papery husk and its unique flavor profile (an inviting sweetness with a subtle bitterness). Nutritionally, *P. peruviana* is rich in vitamin C, vitamin A, dietary fiber, potassium, and bioactive compounds like carotenoids and polyphenols, which provide antioxidant and anti-inflammatory benefits (Puente et al. 2011; Ramadan 2011; Bazalar Pereda et al. 2019).

These attributes, combined with its aesthetic and culinary versatility, position it as a promising fruit for both high-value markets and health-focused consumers, justifying further research and commercial investment.

Recent investigations in *P. peruviana* have focused on its genetics, morphology, evolution, and cultivation to support these efforts. Genetic research has revealed significant intraspecific diversity in *P. peruviana*, highlighting its potential for trait improvement. Genomic analyses have identified markers associated with key agronomic traits, such as fruit size, nutritional content, and stress tolerance, which are valuable for breeding programs (Delgado-Bastidas et al. 2019). Morphological investigations have shown variation in fruit color, husk size, and plant architecture, emphasizing the need for systematic phenotyping to classify and exploit this diversity (Fischer et al. 2014). The evolutionary history of *P. peruviana* places it as a domesticated species within the Andean region, where wild relatives

Fig. 1 Diverse gourmet and commercial grocery products that feature berries of *Physalis peruviana*



and landraces still exist, providing untapped genetic resources for crop improvement (Whitson and Manos 2005; Zamora-Tavares et al. 2016; Martínez et al. 2023). However, although agricultural research has given little attention to these neglected or underutilized crops (Hammer and Heller 2001), taxonomic and phylogenetic investigations offer an opportunity to explore fruit diversity within the genus and uncover potential food resources.

The diversity beyond *Physalis peruviana*: wild sweet *physalis* (WSP)

The genus *Physalis* includes several orphan crops, which are (scientifically) neglected and under-utilized plants not traded internationally (Lopez-Gomollón 2023). Although *Physalis peruviana* is a valuable food resource to address growing food demands, it is not the only *Physalis* species with such desirable fruit traits that have been cultivated in the American continent. *Physalis peruviana* is one of 95 *Physalis* species, all of which are annual or perennial plants characterized by their distinctive papery husk (Zamora-Tavares et al. 2016; Deanna et al. 2019; Martínez et al. 2023). These are usually found in tropical and temperate regions of the world (Martínez et al. 1998a; b), with the center of diversity in Mexico; their origin dates to at least 52 million years ago, during the Eocene (Wilf et al. 2017; Deanna et al. 2020).

Although not all species produce sweet or edible fruits, 15 Wild sweet *Physalis* (hereafter WSPs; Table 1, Fig. 2) are collected from their natural populations for consumption (e.g., Santiaguillo Hernández and Blas Yáñez 2009; Martínez et al. 2023; Moerman 2025). Five of these species show suitable nutritional traits for the sweet berry market, making them promising candidates for cultivation and commercial use (Table 1, Fig. 2; e.g., Valdivia-Mares et al. 2016; Shenstone et al. 2020a, b). For instance, *P. chenopodiifolia* and *P. pubescens* have been extensively studied for their fruit morphology, flavor profiles, and adaptability to various climates (e.g., Whitson and Manos 2005; Valdivia-Mares et al. 2016).

Morphological diversity across WSP

The 15 wild sweet *Physalis* (WSP) species represent a diverse morphological assemblage spanning annual herbs, rhizomatous perennials, and suffrutescent shrubs (Martínez et al. 1998a, 2023; b). Species such as *P. pubescens*, *P. pruinosa*, and *P. grisea* are typically low-growing annuals with diffuse or decumbent branching, while *P. chenopodiifolia*, *P. hederifolia*, and *P. heterophylla* are perennial herbs with more erect, branched habits (Sullivan in press; Martínez et al. 2023). In contrast, *P. viscosa*, *P. cinerascens*, and *P. fendleri* are often rhizomatous perennials adapted to temperate or disturbed habitats, producing persistent underground structures that promote clonal expansion (Barboza 2013; Sullivan in press; Martínez et al. 2023). Leaf morphology varies from the wider and ovate leaves of *P. pubescens*, *P. pruinosa*, and *P. virginiana* to the narrower and lanceolate leaves of *P. lanceolata* and *P. acutifolia*, with indumentum ranging from glabrous (e.g., *P. acutifolia*) to densely pubescent with glandular or non-glandular stellate hairs (*P. chenopodiifolia*, *P. cinerascens*, Sullivan in press; Martínez et al. 2023).

Floral and calyx traits also display substantial diversity among WSPs. Corollas are generally yellow with variable maculations, but flower size ranges considerably, from the small-flowered taxa (e.g., *P. pruinosa*, *P. cinerascens*) to larger-flowered species such as *P. gracilis* and *P. chenopodiifolia* (Sullivan in press; Martínez et al. 2023). The accrescent fruiting calyx varies from moderately inflated forms (e.g., *P. acutifolia*) to fully enveloping, inflated, lantern-like structures in *P. pubescens*, *P. pruinosa*, and *P. grisea* (Martínez et al. 2023), the latter contributing to their post-harvest protection. Calyx ribs (5-angled vs. 10-costate) and texture (membranous vs. more rigid or papery) further distinguish these species, and have been used in systematic treatments of the genus (Whitson and Manos 2005; Martínez et al. 2023).

Fruit morphology exhibits marked differences in size, flavor, and husk adherence (Fig. 2). Species such as *P. pubescens*, *P. pruinosa*, and *P. grisea* bear relatively large, sweet berries and have already attracted attention for cultivation trials (Martínez et al. 2023; Dale et al. 2024). Others, including *P. hederifolia* and *P. gracilis*, produce smaller fruits but retain the characteristic orange berry coloration associated with edible *Physalis* (Martínez et al. 2023). The austral

Table 1 Distribution, reported uses as food resources, and available nutritional research for the wild sweet *Physalis* (WSP) species. “Na” indicates that no reports are currently known

Species	Distribution	Food resource report	Nutritional content reports
<i>P. acutifolia</i> (Miers) Sandwith	Mexico, United States	Kindscher et al. (2012), Martínez et al. (2022, 2023), Moerman (2025)	Valdivia-Mares et al. (2016)
<i>P. chenopodiifolia</i> Lam	Mexico	Martínez et al. (2022, 2023)	Valdivia-Mares et al. (2016), Salcedo-Pérez et al. (2015), Barrientos-Ramírez et al. (2019)
<i>P. cinerascens</i> (Dunal) Hitchc	Mexico, United States	Santiagoullo Hernandez and Blas Yáñez (2009), Martínez et al. (2022, 2023)	Na
<i>P. fendleri</i> A. Gray	South United States	Moerman (2025)	Na
<i>P. gracilis</i> Miers	Mexico	Santiagoullo Hernandez and Blas Yáñez (2009), Enríquez Antonio (2025), Martínez et al. (2023)	Enríquez Antonio (2025)
<i>P. grisea</i> (Waterf.) M. Martínez	Canada, United States	Dale et al. (2024), Martínez (1998a, b, 2023), Shenstone et al. (2020a, b), van Eck (2022)	Na
<i>P. hederifolia</i> A. Gray	Mexico, South United States	Kindscher et al. (2012), Medina-Medrano et al. (2015)	Na
<i>P. heterophylla</i> Nees	United States	Moerman (2025)	Na
<i>P. lanceolata</i> Michx	United States	Moerman (2025)	Na
<i>P. longifolia</i> Nutt	Canada, United States	Kindscher et al. (2012), Moerman (2025)	Na
<i>P. neomexicana</i> Rydb	United States	Kindscher et al. (2012), Moerman (2025)	Na
<i>P. pruinosa</i> L.	Argentina, Bolivia, Mexico, Paraguay, Central America (except Panama and El Salvador)	Shenstone et al. (2020a, b), Martínez (1998a, b, 2023), Arenas and Kamienkowski (2013)	Singh et al. (2014)
<i>P. pubescens</i> L.	Central, North, and South America (United States to Argentina)	Barboza (2013), Martínez (1998a, b, 2022, 2023), Shenstone et al. (2020a, b), Kindscher et al. (2012), Moerman (2025), Quiroga & Kirschbaum (2021)	El Sheikha et al. (2008), Valdivia-Mares et al. (2016), Singh et al. (2014), Rashwan and Khalifa (2017), Shenstone et al. (2020a, b)
<i>P. virginiana</i> Mill	United States, Canada	Moerman (2025)	Na
<i>P. viscosa</i> L.	Argentina, Brazil, Chile, Paraguay, Uruguay, Bolivia	Barboza (2013), Arenas and Kamienkowski (2013)	Na

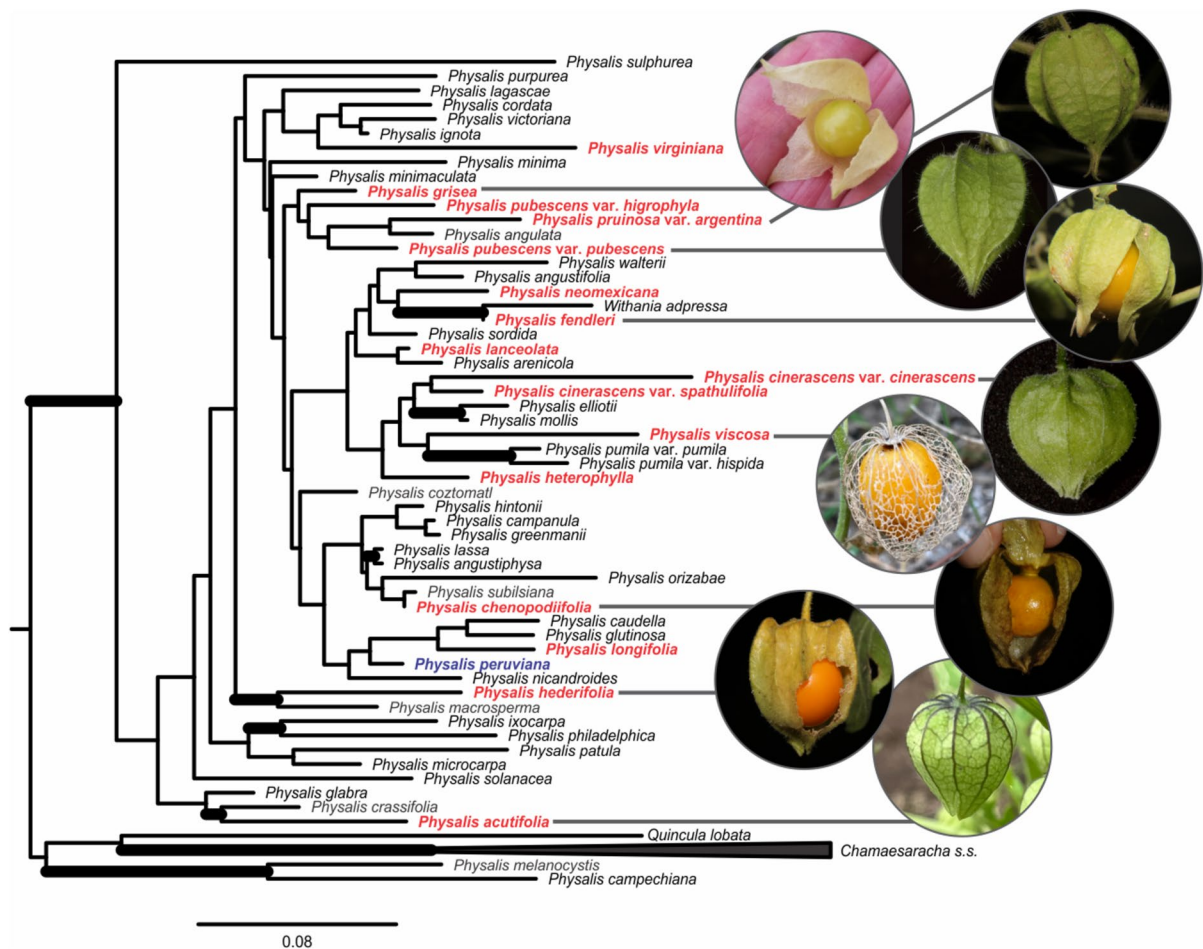


Fig. 2 The most recent phylogenetic hypothesis of *Physalis*, including 55% of the species (Deanna et al. 2019). Wild sweet *Physalis* (WSPs) are highlighted in red across the phylogenetic tree, except *P. gracilis* Miers, which is not shown in the

tree because it does not have molecular data. *Physalis peruviana*, the most studied and cultivated sweet berry of the *Physalis* genus, is colored blue. Bolded branches represent Bootstrap support > 90

species *P. viscosa* and the xeric species *P. acutifolia* and *P. cinerascens* produce smaller berries (Barboza 2013; Martínez et al. 2023), but they are still notable for their robustness, environmental tolerance, and fruit palatability in local contexts (Arenas and Kamienskowski 2013; Barboza 2013; Martínez et al. 2023). Together, these 15 species encompass a continuum of morphological traits linked to fruit protection, dispersal, and environmental adaptation, underscoring their relevance as underutilized genetic resources for crop diversification.

Nutritional research and food value

Phytochemical analyses of several WSPs have revealed high levels of bioactive compounds, such as withanolides, flavonoids, and acyl sugars, which contribute to their potential health benefits and antioxidant properties (Ramadan 2011; Zhang and Tong 2016; Shenstone et al. 2020a, b). These compounds also play a role in pest resistance, enhancing the resilience and agricultural viability of certain species. Recent screenings of acyl sugar profiles across *Physalis* berries indicate broad biochemical diversity, ranging from over 30 distinct compounds in *P. chenopodiifolia* to almost none in *P. grisea* and *P.*

cinerascens (Fig. 3; Nowack et al. 2025). Such variation highlights the potential of WSPs to provide novel flavors, nutraceutical compounds, and food innovation opportunities.

Despite these promising findings, there is a major gap in knowledge regarding the nutritional composition of nine species native to the United States, including *P. longifolia*, *P. neomexicana*, *P. grisea*, *P. fendleri*, *P. cinerascens*, *P. hederifolia*, *P. heterophylla*, *P. virginiana*, and *P. lanceolata*. Similarly, the most austral species, *P. viscosa*, lacks published data on nutritional content or cultivation practices, despite its broad distribution and local use (Arenas and Kamienkowski 2013; Barboza 2013). These gaps highlight

the need for targeted biochemical and agronomic research to evaluate their potential as underutilized food resources.

In addition, several WSPs have not been reported as sweet edible fruits but exhibit traits that suggest their potential for human consumption. These include *P. subilsiana* J. M. Toledo (endemic to Argentina, Bolivia, and Paraguay; noted as a potential food by Arenas and Kamienkowski 2013 and Barboza 2013), the perennial shrubs *P. melanocystis* (B. L. Rob.) Bitter and *P. coztomatl* Moc. & Sessé ex Dunal (both native to Mexico and Mesoamerica, Martínez et al. 2023), and the profusely branched perennial *P. crassifolia* Benth. (growing in coastal dunes and sandy places of Mexico and the United States, Martínez et al. 2023). Collectively,

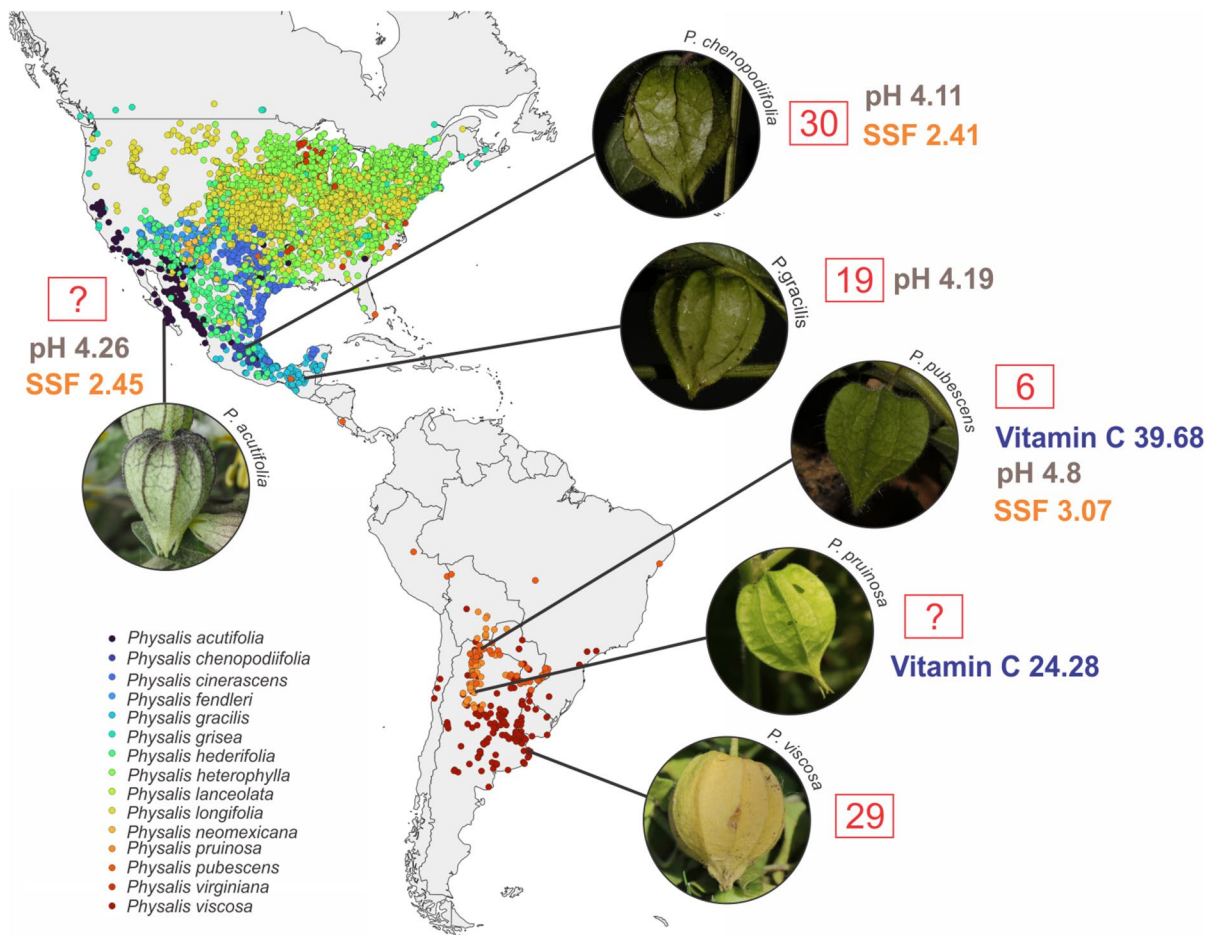


Fig. 3 Distribution of the 15 wild *Physalis* species across the American continent, including photos of some representative species. Acyl sugar numbers recovered from the berries are in a red box next to each *Physalis* photograph. Vitamin C, pH,

and soluble sugars in fruit (SSF) values are included if known (Singh et al. 2014; Valdivia-Mares et al. 2016; Enríquez Antonio 2025)

the biochemical diversity and underexplored edible potential of these WSP species highlight opportunities for expanding minor crop portfolios, functional fruit markets, and breeding programs aimed at improving nutritional quality and stress resilience.

Ethnobotany and agro-economical research

Wild sweet *Physalis* (WSP) species have long-standing ethnobotanical relevance across the American continent, where fruits are collected from wild populations for local consumption and processing. Among the species with the southernmost distribution, *P. viscosa* produces bright orange, sweet berries (Fig. 2) that are traditionally used in marmalades and other preparations, with a native range extending to Patagonia (Fig. 3; Arenas and Kamienskowski 2013; Barboza 2013). These observations suggest the potential for temperate cultivation of austral WSPs outside their native ranges. Molecular genetic research using molecular markers has further highlighted the untapped genetic diversity across *Physalis*, revealing lineages with traits suitable for breeding programs focused on fruit quality, stress resilience, and adaptation to diverse environmental conditions (Whitson and Manos 2005; Martínez et al. 2023; López-Gomollón 2023).

Despite this potential, several species remain underutilized and, in some cases, are perceived as weeds in non-native regions. For example, prairie groundcherries, *P. fendleri* and *P. viscosa*, have become naturalized and invasive in Australia (*P. fendleri* listed as *P. hederifolia* var. *fendleri*, Donaldson 1984; Wu et al. 2019), reflecting their robust growth, high adaptability, and potential to become established in disturbed habitats. These same traits, combined with local edibility, suggest that such species could be incorporated into smallholder or low-input cropping systems if domestication efforts are undertaken.

Currently, only a few WSPs are being evaluated in cultivation beyond the widely grown *P. peruviana*. Trials with *P. pruinosa* and *P. grisea* have demonstrated their potential as specialty fruits suitable for small-scale and community-supported agriculture production systems (USDA 2020). However, the majority of WSPs remain largely unstudied. Integrating traditional knowledge, agronomic trials, and breeding efforts for these species could expand their

utilization as minor crops, diversify food resources, and strengthen resilient horticultural systems.

Acknowledgements RD acknowledges support from the European Union through the Marie Skłodowska-Curie grant (MSCA Agreement No. 101151612). We also thank the Helsinki University Library for supporting open access publication.

Author contributions Conceptualization: RD, PP; Funding acquisition: RD, PP; Supervision: RD, PP; Visualization: TL, RD; Writing—original draft: RD; Writing—review & editing: TL, PP; Project administration: PP.

Funding Open Access funding provided by University of Helsinki (including Helsinki University Central Hospital). H2020 Marie Skłodowska-Curie Actions, MSCA Agreement No. 101151612.

Data availability No datasets were generated or analysed during the current study.

Declarations

Conflict of interest The authors declare that they have no known conflict of interest or personal relationships that could have appeared to influence the work reported in this paper.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Antonio OE (2025) Caracterización del sistema reproductivo y potencial agronómico de *Physalis gracilis* (Solanaceae). Master's thesis, Universidad de Guadalajara
- Arenas P, Kamienskowski N (2013) Ethnobotany of the genus *Physalis* L. (Solanaceae) in the South American Gran Chaco. *Candollea* 68:251–266
- Barboza GE (2013) Flora Argentina: Flora vascular de la República Argentina, vol. 13, Dicotyledoneae Solanaceae. IBODA-IMBIV, CONICET, Buenos Aires
- Barrientos-Ramírez L, Arvizu ML, Pérez ES, Rodríguez SV, Radillo JJV, Reyes BAB, Ruiz-López MA (2019) Polyphenols content and antioxidant capability of wild and

- cultivated *Physalis* species. *Revista Mexicana Cienc* for 10:182–200. <https://doi.org/10.29298/rmcf.v10i51.323>
- Bazalar Pereda MS, Nazareno MA, Viturro CI (2019) Nutritional and antioxidant properties of *Physalis peruviana* fruits from the Argentinean northern Andean region. *Plant Foods Hum Nutr* 74:68–75
- Dale SM, Tomaszewski E, Lippman Z, Van Eck J (2024) Engineering the future of *Physalis grisea*: a focus on agricultural challenges, model species status, and applied improvements. *Plants People Planet* 6:e10536
- Deanna R, Larter MD, Barboza GE, Smith SD (2019) Repeated evolution of a morphological novelty: a phylogenetic analysis of the inflated fruiting calyx in the Physalideae tribe (Solanaceae). *Am J Bot* 106:270–279
- Deanna R, Wilf P, Gandolfo MA (2020) New physaloid fruit-fossil species from early Eocene South America. *Am J Bot* 107:1749–1762
- Delgado-Bastidas N, Lagos-Santander LK, Lagos-Burbano TC (2019) Genetic diversity of 40 genotypes of cape gooseberry *Physalis peruviana* L. using microsatellite markers. *Revista Ciencias Agrícolas* 36:95–107
- Donaldson JS (1984) Chemical control of prairie ground cherry (*Physalis viscosa* L.). *Aust Weeds* 3(1):13–15
- El Sheikh AF, Zaki M, Bakr A, El Habashy M, Monet D (2008) Physico-chemical properties and biochemical composition of *Physalis (Physalis pubescens* L.) fruits. *Food* 2(2):124–130
- Enríquez Antonio O, Zamora-Tavares MP, Solís-Montero L, Rodríguez-Zaragoza FA, Sánchez-Hernández CV, Alcalá-Gómez G, Sánchez-Nuño JA, Vargas-Ponce O (2025) Reproductive system and agronomic potential of wild husk tomato *Physalis gracilis* Miers. Preprint <https://doi.org/10.21203/rs.3.rs-7687132/v1>
- Fischer G, Almanza-Merchán PJ, Miranda D (2014) Importancia y cultivo de la uchuva (*Physalis peruviana* L.). *Rev Bras Frutic* 36:1–15
- Hammer K, Heller J, Engels JMM (2001) Monographs on underutilized and neglected crops. *Genet Resour Crop Evol* 48:3–5
- Kindscher K, Long Q, Corbett S, Bosnak K, Loring H, Cohen M, Timmermann BN (2012) The ethnobotany and ethnopharmacology of wild tomatillos, *Physalis longifolia* Nutt., and related *Physalis* species: a review. *Econ Bot* 66(3):298–310
- Knapp S (2002) Tobacco to tomatoes: a phylogenetic perspective on fruit diversity in the Solanaceae. *J Exp Bot* 53:2001–2022
- López-Gomollón S (2023) *Physalis*: a new model crop to understand plant diversity. *Plant Cell* 35:338–339
- López-Sandoval JA, López-Mata L, Cruz-Cárdenas G, Vibrans H, Vargas O, Martínez M (2015) Modelado de los factores ambientales que determinan la distribución de especies sinantrópicas de *Physalis*. *Bot Sci* 93(4):755–764
- Martínez M (1998a) Revision of *Physalis* section Epiteiorhiza (Solanaceae). *Anales Del Inst Biol Ser Bot* 69(2):71–117
- Martínez M (1998b) Revisión taxonómica de *Physalis* L. (Solanaceae) de México. *Ann Mo Bot Gard* 85:102–129
- Martínez M, Vargas-Ponce O, Zamora-Tavares P (2022) *Physalis philadelphica* Lamarck *Physalis angulata* L. *Physalis chenopodiifolia* Lamarck *Physalis cinerascens* (Dunal) CL Hitchk. *Physalis pubescens* L. *Physalis acutifolia* (Miers) Sandwith *Physalis coztomatli* Dunal Solanaceae. *Ethnobotany of the mountain regions of Mexico*. Springer International Publishing, Cham, pp 1–11
- Martínez M, Vargas-Ponce O, Zamora-Tavares P (2023) Taxonomic revision of *Physalis* (Solanaceae) in Mexico. *PhytoKeys* 224:1–133
- Medina-Medrano JR, Almaraz-Abarca N, González-Elizondo MS, Uribe-Soto JN, González-Valdez LS, Herrera-Arrieta Y (2015) Phenolic constituents and antioxidant properties of five wild species of *Physalis* (Solanaceae). *Bot Stud* 56:24
- Moerman D (2025) Native American Ethnobotany, <http://naeb.brit.org/>. Accessed Nov 23, 2025
- Nowack L, Deanna R, Smith SD, Schenck CA (2025) Novel production of structurally diverse and sticky defense metabolites on wild tomatillo fruits. *bioRxiv*. <https://doi.org/10.1101/2025.07.16.665232>
- Puente LA, Pinto-Muñoz CA, Castro ES, Cortés M (2011) *Physalis peruviana* Linnaeus, the multiple properties of a highly functional fruit: a review. *Food Res Int* 44:1733–1740
- Quiroga RJ, Kirschbaum DS (2021) *Physalis* (goldenberry): native fruit species of the sub-andean yungas with high cultivation potential in Argentina. *Hortic Argent* 40(103):90–114
- Ramadan MF (2011) Bioactive phytochemicals, nutritional value and functional properties of cape gooseberry (*Physalis peruviana*): an overview. *Food Res Int* 44:1830–1836
- Rashwan MRA, Khalifa AH, Zeiad FKA, Mohamed MIA (2017) Nutrient and phytochemical compounds of persimmon and husk tomato. *Assiut J Agric Sci* 48:102–112
- Royal Botanic Gardens, Kew (2016) The state of the world's plants report 2016. Royal Botanic Gardens, Kew
- Salcedo-Pérez E, Arvizu ML, Vargas-Radillo JJ, Vargas-Ponce O, Bernabe-Antonio A, Barrientos-Ramírez L (2015) Contenido mineral y tamizaje fitoquímico en *Physalis chenopodiifolia* Lam. en condiciones de desarrollo. *Rev Mex Cienc* for 6:58–73
- Santiaguillo Hernández JFS, Blas Yáñez SB (2009) Aprovechamiento tradicional de las especies de *Physalis* en México. *Rev Geogr Agric* 43:81–86
- Shenstone E, Lippman Z, Van Eck J (2020a) A review of nutritional properties and health benefits of *Physalis* species. *Plant Foods Hum Nutr* 75(3):316–325
- Shenstone E, Lippman ZB, Van Eck J (2020b) Groundcherries (*Physalis* spp.): a new fruit crop for the northern United States. *HortScience* 55:1512–1520
- Singh DB, Ahmed N, Lal S, Mirza A, Sharma OC, Pal AA (2014) Variation in growth, production and quality attributes of *Physalis* species under temperate ecosystem. *Fruits* 69:31–40
- Sullivan JR (In press) *Physalis*. In: *Flora of North America* Editorial Committee (eds.), *Flora of North America North of Mexico*, vol. 14. New York and Oxford: Oxford University Press
- United Nations. Global issues: Population. <https://www.un.org/en/global-issues/population> [accessed on December 22, 2024]
- USDA (2020) Goldenberry (*Physalis peruviana*) production systems for CSA farms USDA REEIS. Retrieved Feb 25, 2024, from <https://portal.nifa.usda.gov/web/crisprojec>

- <https://doi.org/10.1007/s00127-021-02077-7> goldenberryphysalis-peruviana-production-systems-for-csa-farms.html
- Valdivia-Mares LE, Zaragoza FAR, González JJS, Vargas-Ponce O (2016) Phenology, agronomic and nutritional potential of three wild husk tomato species (*Physalis*, Solanaceae) from Mexico. *Sci Hortic* 200:83–94
- Van Eck J (2022) The *Physalis* improvement project: blending research with community science: how community science can advance research. *EMBO Rep* 23(1):EMBR202153918
- Waterfall UT (1956) A taxonomic study of the genus *Physalis* in North America north of Mexico. Doctoral dissertation, University of Oklahoma
- Whitson M, Manos PS (2005) Untangling *Physalis* (Solanaceae) from the physaloids: a two-gene phylogeny of the Physalinae. *Syst Bot* 30:216–230
- Wilf P, Carvalho MR, Gandolfo MA, Cúneo NR (2017) Eocene lantern fruits from Gondwana and the early origins of modern Solanaceae. *Science* 355:71–75
- Wu H, Stanton R, Lemerle D (2019) Seed fecundity, persistence and germination biology of prairie groundcherry (*Physalis hederifolia*) in Australia. *Weed Sci* 67:77–82
- Zamora-Tavares MP, Vargas-Ponce O, Sánchez-Martínez J, Valdivia-Mares LE (2016) Traditional management of a small-scale crop of *Physalis angulata* in western Mexico. *Genet Resour Crop Evol* 63:1383–1395
- Zamora-Tavares MP (2016) Relaciones filogenéticas de la subtribu Physalinae (Solanaceae) con énfasis en las especies americanas. Doctoral dissertation, Universidad de Guadalajara
- Zhang Y, Tong L (2016) Physicochemical characteristics and phytochemical profiles of yellow and red *Physalis* fruits cultivated in China. *Plant Foods Hum Nutr* 71:245–251

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.