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PRACTICE BRIDGE

Quelites—Agrobiodiversity beyond our crops

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The monoculture of a handful of energy-dense crops that dominates contemporary agriculture has resulted in an erosion of agrobiodiversity, environmental issues, agroecosystem dependency on off-farm inputs, and diets with poor diversity in nutrients and flavors. However, diversified agriculture persists in communities characterized by subsistence farming, many of them Indigenous. Although movements across Latin America aim to rescue agrobiodiversity, they are widely limited to cropping system diversification, including practices such as crop rotations, intercropping, and cover crops. The agrobiodiversity of plants associated with crops, often labeled as weeds, is commonly not considered in this context. Yet edible weeds are the essential components of traditional food systems where they increase the functional diversity of agroecosystems and contribute to human nutrition. In Mexico, the term "quelite" describes noncultivated but edible plants growing on a crop field. Across the American continent, there are nutritious quelites that are commonly perceived as "weeds." In this article, we discuss the concept of quelites, their origin in traditional Mexican agriculture, their significance for agroecosystem diversification, and their potential for the future. We demonstrate, with 12 examples, that quelites have always been part of agroecosystems across the Americas. We aim to spread the concept of quelites beyond traditional farming in Mexico to promote the use of these promising plants. We conclude the article with suggestions for strategies to achieve this goal. *Please refer to Supplementary Materials*, **Full text Spanish version of this article**, *for a full text Spanish version of this article.*

Keywords: Quelite, Maleza (weed), Mesoamérica, Conocimiento tradicional ecológico (traditional ecological knowledge), Agroecología (agroecology), Soberanía alimentaria (food sovereignty)

Introduction

Despite the essential role that the diversification of agroecosystems plays in the resilience of food systems to stressors such as climate change, the industrialization of the food system in the 20th century resulted in a global loss of agrobiodiversity. The predominance of monocultures of only a dozen species (Motley et al., 2006) led to a rigid differentiation between the agrobiodiversity desired by producers (i.e., calorie-dense and easy-to-manage crops in industrialized systems, which commonly go hand in hand with the use of agrochemicals, agromachinery, and genetically modified organisms) and undesired plants known as "weeds." Weeds commonly describe wild species that, being part of the biodiversity associated with crops, colonize agroecosystems within and around the managed areas (Gaba et al., 2016). The anthropocentric distinction between crops and weeds does not consider the ecological and evolutionary causes by which weeds affect crop yield and management, nor the important ecosystem services these plants can provide (Mohler et al., 2001; Jordan and Vatovec, 2004). Likewise, it is widely unknown that a large part of those wild plants classified as weeds can be used as human or animal food and medicine (Turner et al., 2011).

Edible weeds are typically overlooked and disparaged by politics, research, education, gastronomy, medicine, and industrialized agriculture, despite their cultural, nutritional, and medicinal significance. Given their (1) abundance in the fields (although commonly unintended and undesired) where they grow without depending on external inputs, (2) the ecosystem services weeds can provide, and (3) their potential use as the sources of medicine and food, we suggest reconsidering the prevailing paradigm of "eradication agriculture" as the only way to deal with weeds. In fact, in many Indigenous communities, characterized by traditional and subsistence agriculture, a more holistic view of these plants distinguishes case by case—and plant by plant—whether a spontaneously growing plant may be beneficial or harmful to an agroecosystem. This approach involves making use of nutrient-rich weeds as the sources of food and medicine. For example, in

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different Mesoamerican cultures, the term *quelite* refers to a weed that is edible for humans.

Despite an abundance of literature on weed management (both in traditional and industrialized systems) and its impact on agroecosystems, the potential of weeds, especially as the sources of food and medicine, has not been discussed and explored in depth since politicians, agronomists, and other stakeholders have not prioritized this topic. In this article, we propose the term "quelites"—a word of Nahuatl origin—to fill this gap. The use of the term "quelites" distinguishes edible weeds from both (1) nonedible weeds and (2) edible wild plants outside agroecosystems. We consider the dissemination of this term essential to promote this concept among food system actors across Latin America. For us, quelites are not simply "weeds" but multifunctional plants with direct benefits for humans and ecosystems; and traditional agricultural practices throughout the American continent have delivered a knowledge base for their effective use and management.

This article is the result of a literature review on quelites from across the Americas. What we present here is not new for the communities that regularly benefit from these plants. Yet, much of the academic world, except for ethnobotanical studies, lacks systematic work on this topic. Presented is an agroecological and sociocultural context on quelites, with a focus on their contemporary rather than historical importance. Our objective was not to undertake a systematic review of all quelites in the Americas but rather to stimulate a discourse on these plants. We aim to elucidate the reasons why scientists, activists, and decision-makers should take an interest in quelites.

We exemplify the potential of quelites with 12 plants from 4 different regions and climates of the Americas: Mesoamerica, the Caribbean, tropical South America, and temperate South America. For each of these regions, we present 3 quelite species with potential to become regularly used foods, but which are currently subject to considerable mechanical and agrochemical interventions.

Referring to the origin of the term "quelite" in the Americas and appreciating the work of Indigenous communities throughout the continent, we originally published this article in Spanish.

Methods

We conducted a narrative, descriptive, and critical literature review (Guirao Goris, 2015) on quelites in the Americas. Our objective was to identify, analyze, evaluate, and interpret the body of evidence on quelites in existing Spanish and English publications, specifically on the botany, agroecology, and uses (emphasizing food uses) of quelites. This work was complemented with a review of literature on related topics, including agrobiodiversity in general, "superfoods," or peasant movements to rescue agrobiodiversity. Our literature search was conducted in online databases, especially Web of Science and SciELO. Likewise, scientific articles, books, manuals, databases, and select websites were considered.

The team of authors of this publication brings together experts from different parts of the American continent and areas of expertise as diverse as agroecology, food systems, horticulture, anthropology, and sociology. Each author worked on topics related to their fields of knowledge. The selection of literature sources was the responsibility of each of the coauthors.

Our article serves as a practical bridge, emphasizing the correlation between existing knowledge—both scientific and traditional ecological—about quelites and contemporary factors. We explore challenges and opportunities for increased utilization of quelites in our food systems. Our primary objective was to initiate a discourse on quelites, and we acknowledge that this approach has resulted in a subjective selection of sources cited in our article.

Results and discussion

Agrobiodiversity and its significance for food security and ecosystems

Agrobiodiversity includes all domesticated genetic resources used to obtain agricultural products, further species that support the functioning of agroecosystems, as well as associated wild plants and animals, and occasionally also microorganisms (Howard, 2010; Herforth et al., 2019). Historically, agricultural systems were predominantly diversified. However, the third agricultural revolution, which emerged in the early 20th century in industrialized countries and later globalized as the "Green Revolution" in the second half of the century, was marked by the mechanization and homogenization of food production. As a result of these transformations, both global inter- and intraspecific agrobiodiversity have significantly declined within a relatively short period (Howard, 2010). While the total number of domesticated plant species is around 7,000, today, just 15 crops provide more than 80% of the global dietary caloric intake (Motley et al., 2006).

Nonetheless, diversified agriculture persists in many subsistence agroecosystems (Howard, 2010), which are typically based on agroecological principles and often mimic the biodiversity and functioning of local ecosystems (Altieri and Nicholls, 2020). In this way, multiple benefits are generated, including the effective use of nutrients and water, stimulation of soil microflora and soil organic matter content, resilience to pests, efficient crop management, high per-plant yield, and the sequestration of atmospheric carbon (Gliessman, 1985; Letourneau et al., 2011; Altieri and Nicholls, 2020). Furthermore, diversification serves as an effective strategy to enhance the resilience of agroecosystems to external factors, such as climate change, by diminishing the risk of crop loss in the event of a natural disaster (Rosset et al., 2011; Zimmerer et al., 2019; Béné, 2020). Agrobiodiversity can also generate benefits for human health and nutrition, as it provides a diverse diet with foods rich in micronutrients (Arimond et al., 2010; Campbell et al., 2011; Whitmee et al., 2015). Finally, agrobiodiversity contributes nonmaterial values to agricultural communities, enriching traditional ecological knowledge (TEK), including cultures, languages, and diets (Zimmerer et al., 2019; Ebel et al., 2021).

Weeds, arvenses, and quelites

Malezas, *hierbas malas*, *yuyos*, *matojos*, *matorrales*, *arvenses*, *mal monte*, *buen monte*, or *quelites* are some of the many Spanish terms[1] for wild plants that are part of the associated biota and colonize agroecosystems inside and outside the cultivated fields.

Since prehistoric times, humans have used wild plants for food and other needs. Starting around 12,000 years ago with the first agricultural revolution, humans began to select, plant, and care for specific species that were considered crops or cultivated plants, thus initiating agriculture in different parts of the world. As a consequence, regular soil disturbances induced by agricultural practices and the availability of nutrients, water, and light have created suitable habitats for wild plants, called here *arvenses*,[2] to colonize agroecosystems. Over time, various crops and their associated *arvenses* were introduced to different regions of the world (Gaba et al., 2016).

Arvenses are vascular plants that grow, reproduce, and disperse in habitats strongly altered by humans but without human support (Baker, 1974; Godinho, 1984; Vibrans, 2016). Primarily therophytes, *arvenses* are highly successful plants adapted to frequently disturbed sites rich in resources demanded by plants, such as agricultural environments. On these sites, *arvenses* may disturb or impede the development of crops, since they compete for essential resources, can be hosts of phytosanitary diseases, and reduce the yield and the quality of the harvest (Altieri et al., 1996; Mohler et al., 2001; Blanco-Valdes, 2016; Gaba et al., 2016; Bourgeois et al., 2019). For these reasons, agricultural producers widely perceive *arvenses* as "weeds," species that, in the opinion of some, are harmful or undesirable due to their negative effects on human activities and the costs associated with their management (Blanco-Valdes, 2016). Agronomists and conventional producers respond to the presence of these plants with control tactics focused on achieving a "weed-free" field through interventions, such as tillage and the use of agrochemicals. Other agricultural activities, including crop rotation, fertilization, and harvesting, play a crucial role in determining the presence and abundance of *arvenses* in agroecosystems (Booth and Swanton, 2002).

A holistic approach to agroecosystem management requires analyzing *arvenses*, not only for their potential negative impact on agricultural production but also for the ecosystem services they can provide. As parts of the associated diversity within agroecosystems, they can, for example, contribute to soil conservation, nutrient recycling, and the production of organic fertilizers. Likewise, they can provide shelter and food to pollinators, parasitoids, and other natural enemies of pests (Jordan and Vatovec, 2004). One example is *Amaranthus retroflexus* L., commonly known as redroot pigweed. It is considered a weed in different agricultural systems but contributes to soil conservation by having a deep root system that helps improve soil structure and reduce erosion. Furthermore, its rapid growth and high biomass allow efficient recycling of nutrients. In addition, pigweed is a valuable food source for pollinating insects (Blanco-Valdes, 2016).

The classification of plants as crops or *arvenses* is subjective and determined by their usefulness for the producer, the sociocultural environment, and market and consumer perceptions (Holzner, 1982; Randall, 1997). Crops and *arvenses* usually share physiological characteristics, ecological requirements, and evolutionary origins (Blanco-Valdes, 2016). In fact, several *arvenses* are descendants of crops, and numerous crops are descendants of *arvenses* (Doebley, 2006; Ellstrand et al., 2010). Filatova et al. (2021) suggest that oats (*Avena sativa* L.) and barley (*Hordeum vulgare* L.) are examples of *arvenses* reinterpreted as crops. The distinction between crops and *arvenses* is usually limited to crop management but does not consider the ecological causes by which *arvenses* colonize agroecosystems, nor the ecosystem services these plants can provide (Chávez-Servia, 2004; Jordan and Vatovec, 2004; Vibrans, 2016).

In most traditional agricultures, a rigid distinction between crops and *arvenses* is not recognized (**Box: The concept of weeds in Indigenous societies**). In these production systems, specific wild plants are actively managed, suggesting that there is a false dichotomy around the ideas of agricultural and wild plants (Bharucha and Pretty, 2010). However, there have always been plants associated with damage, loss, or inconvenience (Contreras and Moreno, 2005; Gaba et al., 2016). Although *arvenses* can affect crop yields, traditional producers count on TEK, which allows them to manage their agroecosystems holistically (Turner et al., 2011). For example, traditional farmers in Mexico do not refer to *arvenses* as weeds, but as "monte"; and they usually deliberately leave them in the fields as a second harvest (Bye, 1981; Altieri and Trujillo, 1987). These farmers possess the ability to distinguish between "buen y mal monte" ("good and bad wild plants") and employ this knowledge as a criterion for selective weeding based on the usefulness of a plant and its effects on the soil and crops (Chacón and Gliessman, 1982). Practices such as selective weeding and knowledge of the tolerance levels of crops to the presence of *arvenses* within and around their fields allow farmers to ensure the production of their crops while simultaneously increasing the nutritional diversity available to their families (Altieri, 2016). In Tlaxcala, Mexico, corn producers "attract" wild plants to their fields considering their tolerable densities (Altieri and Trujillo, 1987). Currently, many traditional producers practice "non-cleaned" fields. They, thus, increase the gene flow between crops and their wild relatives and contribute to a process of progressive domestication (Altieri, 2016). While the management of *arvenses* such as clover (*Trifolium* spp.), cocksfoot (*Dactylis*

1. This article was originally composed in Spanish, a language that, owing to the integration of traditional ecological knowledge from various indigenous communities, abounds with terms that, when translated into English, usually mean "weeds" and, on occasion, are also referred to as "wild plants."

2. We decided to maintain the Spanish term "arvenses" for spontaneously growing wild plants as we considered the English terms "weed," "wild plant," or "noncrop plant" either too unspecific or misleading.

Box: The concept of "weeds" in Indigenous societies

The concept of "weeds" is not rooted in the pre-Hispanic ancestry of the Maya of the Yucatan Peninsula. Its use comes from the industrialized agriculture model, which is focused on monoculture. A search in colonial Maya dictionaries reveals the existence of the word "*xiu*," which refers to a green/plant that grows between corn. The following expression can be found in the *Bocabulario de Maya Than* dictionary: "*Tippil u cah xiu yokol a nalob*" and is translated with "Creciendo ba la hierba sobre tu maíz [the green is growing over your corn]" (Acuña, 1993). However, there is no connotation of this green being "bad" *per se*, and the expression simply refers to the existence of a large amount of some type of green in the cornfield: "*mucchahal nal tumen xiu. l. ich xiu*" or "los maízes con la mucha yerba [the corn with a lot of greens]" (*Bocabulario de Maya Than).* In other words, quantity does not equal evil (and "green" does not equal "weed").

The word *xiu*, according to a (male) interlocutor, is usually used to name a shrub or plants that are not *che'* (tree/wood). Thus, *K'aak'as k'áax* (very bad green/weed) is used to refer to a plant that can physically hurt someone, like the *p'óop'ox* (*Tragia yucatensis* Plum.) or the *chéechem* (*Metopium brownei* Roxb.). "*Ku pech'ik páak'áal*" indicates that such a plant is difficult to eliminate and that it affects or smothers the crop. Thus, the concept of "evil" here refers to a large amount of plants in the wrong place. For traditional corn farmers, *K'aak'as k'áax* is more related to plants that "flood" cornfields and "press" the corn down. One example of such a plant would be the *taj* (*Viguiera dentata* Spreng.), which germinates in very large quantities and grows quickly, shading the corn plants. The attribute "bad" then, has to do with the many *taj* plants affecting the corn and not with the *taj* plant itself.

Another (male) interlocutor told us: "The only bad plant is the good one, as Chico Che said in his famous song *En una mata de mota* ["In a bush of weed," weed referring here to cannabis]: *En una mata de mota, mi hamaca yo la colgué* ["In a bush of weed, I hung my hammock"] . . . And the other thing, now talking serious, is that what for normal people is a "bad plant," for our grandfathers (*jmeeno'ob*) is medicine . . . And sometimes, weeds are the *contra* [solution] to bad disease."

"The truth"—told us by a female interlocutor—"is that humans are the only weeds. Therefore, we give them nicknames like the following: *k'ak'as xiu*, contentious people who create problems or who do not have harmonious intentions, who are biased or gossiping, and who disrupt healthy coexistence. It's the bad of the good."

Among the Yucatecan Maya, the concept of "weed" is beautifully ambiguous. On the one hand, they are clear that weeds are difficult to eliminate and that they "harm" the corn by pressing it down. On the other hand, they recognize that they could be "good" plants because they are medicinal and allow them to address health problems. That is, for the Maya, the good of the bad is the flavor of life.

glomerata L.), or pennycress (*Thlaspi arvense* L.) generates abundant work for conventional producers, other farmers value these plants as forage, cover crops, food, or energy sources (Zanetti et al., 2019; DeMartini, 2020; Schonbeck, 2021).

Between 20% and 30% of the planet's plants are palatable and edible (Turner et al., 2011), including a considerable number of *arvenses* (Bourgeois et al., 2019). Numerous edible *arvenses* are rich in vitamins, minerals, or antioxidants and can contribute significantly to the nutritional quality of the human diet (Kuhnlein and Turner, 2020). In Mesoamerican cultures, the term "quelite" describes *arvenses* that are edible for humans. In this article, we maintain this definition and want to propose it as a nomenclature for future academic discourse to distinguish "quelites" from non-edible *arvenses* and wild plants not associated with agroecosystems. We believe that the word "quelite" perfectly brings together the idea of "edible weed" in any contemporary agroecosystems with a concept that has its origins in traditional American agriculture. However, any equivalent to the word "quelite" may equally enrich this discourse.

Quelites and TEK

Rooted in the culture and identity of Indigenous peoples, rural communities, and peri-urban areas, quelites and wild plants constitute a fundamental element of food systems. They increase agrobiodiversity, which reduces the risk of harvest losses due to environmental factors and increases the resilience of agroecosystems (Mahapatra and Panda, 2012). They are also adapted to local and challenging conditions, promote dietary diversity, and can be an essential element of food sovereignty at the community and family level (Flyman and Afolayan, 2006; Boedecker et al., 2014). Essential for the identification, collection, and preparation of quelite-based foods, TEK plays a crucial role. Quelites, along with the TEK required for their utilization, form an integral part of the biocultural identity of Indigenous and local communities. They significantly influence traditional food, rituals, and lifestyle. In this regard, the risk of losing TEK poses a threat to the conservation and sustained utilization of quelites, which represent a substantial proportion of the global food basket (Bharucha and Pretty, 2010).

The concept of TEK is defined as "a cumulative set of knowledge, practices, and beliefs that evolves through adaptation processes. It is transferred from generation to generation by cultural transmission and pertains to the relationship of living beings, including humans, with each other and with their environment" (Berkes et al., 2000). Such knowledge usually varies among individuals in a community according to their gender, age, and role. For example, in many societies, women have greater knowledge of agrobiodiversity conservation and the use of different agricultural and wild species and varieties than men. They are the custodians of a large part of ancestral wisdom and recognize a greater number of agricultural varieties and edible plants, their properties, and their uses (Baldinelli, 2017).

Indigenous peoples have a unique wisdom specific to where they live, essential for sustainable resource management. Today, most of global agrobiodiversity is concentrated in their lands and territories. Therefore, a better understanding of the holistic management of their fields can shed light on how to move toward more resilient, respectful, and harmonious food systems (Roy et al., 2016). However, as their communities move away from land-based activities and livelihoods and migration to urban areas increases, young Indigenous families working

Box: Food of the poor and food of the rich—The perception of the Maya

The concepts of "food for the poor" and "food for the rich" are lost in the mists of time. Before the Spanish Conquest, in the Mayan city of Mayapán, which flourished between 1200 and 1450 CE, prized deer meat was widely distributed in the city, although poor farmers "could not even provide themselves with an iguana" (Pilcher, 2020). Unlike this meat product, corn was a fundamental part of the diet for both rich and poor households. In Europe, corn, referred to as "panizo" in 1492 by Christopher Columbus, was quickly accepted, assimilated, and placed almost at the same level as wheat, the basis of the European diet. It was considered a "humble" cereal, similar to rye and barley (Quintanar Cabello, 2020). In comparison to wheat, corn, during the 16th and 17th centuries, had a very low social perception.

Also on the Yucatan, corn was the cereal with which "the lowly people make bread." Those who consumed it often did so in anonymity, fearing being stigmatized for consuming a supposedly unworthy food due to the lack of wheat bread (Quintanar Cabello, 2020, Introduction section).

The food of the poor is opposed in binary terms to the food of the rich. The food of the poor is what the lumpenproletariat "swallows" and consists of plant-based foods such as beans or chaya; the "good food" is what those who see themselves as belonging to the upper social classes enjoy, like "...the presumptuous rich, people of reason, and those who are uplifted or feel superior to others ... those who possess (or consider themselves to possess) a dominant position in the social structure and, therefore, consume different foods—wheat bread and real meat" (Velázquez Galindo, 2021).

outside rural communities do not have the opportunity and, in some cases, the interest to acquire TEK about agriculture, food, and the interaction of human beings with their biotic and abiotic environment (Baldinelli, 2018). Therefore, as long as a global transition persists from traditional to more simplified food systems and energy-rich diets, the knowledge about the utilization of quelites and edible wild species will continue to erode. This is attributed to environmental pressures, the neglect of TEK, and the undervaluation of these plants in the global agri-food system. In many developing countries, a large number of individuals have become reluctant to consume traditional dishes and products that are perceived as "food of the poor" (**Box: Food of the poor or rich—The perception of the Maya**). However, in most rural environments, wild species are still being used, particularly in times of food scarcity or as a complement to the predominant diet (Borelli and Hunter, 2013; Boedecker et al., 2014).

Peasant movements toward the rescue of the quelites

The neoliberal economic policies of recent decades have favored industrial and negatively affected peasant agriculture, resulting in a loss of agrobiodiversity and TEK about its management and an imbalance between the socioeconomic reality of peasants and the large corporations that predominate the global food system (Alonso-Fradejas et al., 2015). In response, movements have emerged around the world to rescue peasant agriculture (Torres and Rosset, 2016). These movements promote field management based on agrobiodiversity and with low dependence on external inputs (van der Ploeg, 2010; Altieri and Toledo, 2011).

In Latin America, there are important local initiatives where farmers exchange and share knowledge, genetic material, food, and recipes. For example, the *Feria de Intercambio de Saberes* (Knowledge Exchange Fair) of the Maní Ecological Agriculture School in Mexico (Pérez et al., 2011) and the *Organización Boricua* (Boricua Organization) in Puerto Rico (McCune et al., 2019). Several peasant schools and universities are related to cooperatives and peasant networks, for example, the *Movimiento Campesino de Santiago del Estero* (Peasant Movement of Santiago del Estero) in Argentina (MoCaSE, 2023), the *Escuelas Campesinas de Agroecología* (Peasant Schools of Agroecology, ECAS) in the municipality of Tuluá, Colombia (Álvarez Ramírez and Castaño Arcila, 2014), and the *Escuela de Agricultura Ecológica de Maní* (Maní Ecological Agriculture School; U Yits Ka'an Ecological Agriculture School, 2023), among many others, recognize agrobiodiversity as a pillar of peasant food sovereignty. Some of these networks organize fairs and events dedicated to the exchange of seeds and recipes. Beyond these local and regional initiatives, some organizations operate at the national level such as the *Movimiento Agroecológico de la Asociación Nacional de Agricultores Pequeños* (Agroecological Movement of the National Association of Small Farmers, ANAP) in Cuba (Rosset et al., 2011).

Internationally, *La Vía Campesina* is a movement that emphasizes the intrinsic relationship between food sovereignty, the management of agroecosystems, local cultural practices, and balanced diets (La Via Campesina, 2015). Most of these initiatives and organizations are based on traditional agriculture and agroecological management, which in many parts of Latin America implies diversified agroecosystems that include quelites. The organization *Vinculación y Desarrollo Agroecológico en Café* (Coffee Outreach and Agroecological Development, VIDA AC) in the state of Veracruz, Mexico, explicitly highlights quelites as strengthening peasant identity and an essential component of healthy diets (Pontes et al., 2021).

On the consumer side, the Slow Food movement, a global organization that opposes the standardization and homogenization of the food system, has recognized the importance of quelites for Mexican food (Slow Food Mexico, 2022). This organization seeks to rescue food establishments, dishes, and products to combat the decline of people's interest in their food and its origin (Lotti, 2010). As a consequence, in Mexico, and also in other parts of the Latin American continent, the consumption of quelites is no longer limited to homes or small kitchens but is an essential component of a new gourmet cuisine based on traditional recipes (Castro-Lara et al., 2014; EFE, 2017).

The aforementioned movements focus on agrobiodiversity in general, traditional agriculture, and the corresponding cuisines, which is reflected in their publications, programs, and manifestos. However, they rarely specifically emphasize quelities as important elements to obtain and maintain this agrobiodiversity. We take the agendas of these movements as a starting point to develop the section "Policies and practices to promote agrobiodiversity beyond crops."

Quelites as "super foods"

The term "super food" is generally used for plants with exceptionally high concentrations of nutrients and/or natural substances beneficial for human health, attributed to possessing properties that enhance well-being and vigor. In this context, many plant species may be considered to be "super foods"; however, this term is more frequently used to promote the marketing of species perceived to be exotic, of recent introduction, or already known but traditionally not widely used in markets for targeted consumers (Ebel et al., 2023). Following that notion, specific quelites could be classified as "super foods."

Weedy amaranths, for example, are rich in lysine, threonine, and tryptophan, which are essential amino acids relatively scarce in plant species (Nimbalkar et al., 2012; Coelho et al., 2018), in addition to having high content of proteins and diverse minerals and vitamins. Similarly, quelites such as cobblers pegs (*Bidens pilosa* L.) have a high protein concentration in their leaves (Alikwe et al., 2014), while purslane (*Portulaca oleracea* L.) is richer in beta carotene, omega-3, potassium, and magnesium than more common vegetables (Rodríguez Vieyra et al., 2021). Also, plants that for high-income countries used to be considered weeds or unimportant plants are now accepted and even recognized as "super foods" inherited from other civilizations; that group of plants includes quinoa (*Chenopodium quinoa* C.L. Willdenow), chia (*Salvia hispanica* L.), maca (*Lepidium meyenii* Walp.), and moringa (*Moringa oleifera* Lam.), among others.

Examples of promising quelites

In this section, we present quelites from across the American continent, emphasizing 4 regions: Mesoamerica, tropical South America, the Caribbean, and temperate South America. In the case of Mesoamerica, where a culture of quelite consumption exists, we highlight quelites that have broad distribution and are commonly used. In the other regions, we focus on quelites that are often considered "weeds" but have significant nutritional potential that is currently underutilized. For each region, we present 3 examples of promising quelites (**Table 1**).

Quelites of Mesoamerica

Mesoamerica, particularly Mexico, is the land of the quelites. The term "quelite" comes from the Nahua word *quilitl*. It has its correspondence in various Indigenous languages (Castro-Lara et al., 2014), where it means "edible wild plants" or similar (Blanckaert et al., 2007). Although Mexican consumers usually limit their understanding of quelites to "leafy greens" (Molina Martínez, 2000; Vibrans, 2016), traditional producers use quelite more broadly for uncultivated or cultivated plant species in general (although not all noncrops are considered quelites). In Tabasco, Mexico, for example, there is a classification system that divides noncrops into good and bad *arvenses*, according to their potential use (as food, medicine, or for ceremonies) and their effect on the main crops (Chacón and Gliessman, 1982).

Mexico has a diverse flora and *arvenses* are no exception: They encompass around 3,000 species (Espinosa-García et al., 2004; Vibrans, 2016) with a long history of coevolution with anthropogenic disturbance, particularly by agriculture (Madamombe-Manduna et al., 2009). Milpas (corn fields with or without intercropping) are the typical habitat of quelites, while most traditional medicinal wild plants grow in ruderal or wild habitats (Blanckaert et al., 2007; Vibrans, 2016).

Most quelites in Mexico are native, but various species native to Europe have also been acknowledged as quelites. Throughout Mexico, about 250 species are considered quelites belonging to different botanical families (Castro-Lara et al., 2014; Mapes and Basurto, 2016). This list includes annual plants, such as epazote (*Chenopodium ambrosioides* Mosyakin & Clemants), huazontle (*Chenopodium berlandieri* Moq. ssp. *nuttaliae*), seepweed (*Suaeda nigra* J.F.Macbr), diverse amaranths (*Amaranthus* spp.), papalo (*Porophyllum ruderale* Cass.), violetta (*Anoda cristata* L.), chamomile (*Matricaria chamomilla* L.), common sowthistle (*Sonchus oleraceus* L.), Virginia pepperweed, watercress (*Nasturtium officinale* W. T. Aiton), cobblers pegs, wild mustard (*Brassica rapa* L.), and purslane; as well as perennials including hierba santa (*Piper auritumel* Kunth), dandelion, silver wormwood (*Artemisia ludoviciana* Nutt.), esculent lead tree (*Leucaena esculenta* de Wit), rattlebox (*Crotalaria longirostrata* Hook), and chaya (Molina Martínez, 2000; Vibrans, 2016).

Many quelites are gathered, tolerated, and even desired in traditional agroecosystems (Castro-Lara et al., 2014). They are also frequently part of crop rotations, specifically wild legumes used as green manures. Others, such as epazote, serve to control soil nematodes (Altieri, 2016). Specific quelites such as purslane, romerito, and amaranths are occasionally produced in conventional systems and even in monocultures (Castro-Lara et al., 2014; Mapes and Basurto, 2016).

The consumption of quelites has been documented since precolonial times in Mexico. Today, it still constitutes an important part of the diet in various regions. However, throughout Mexico, the consumption of quelites has decreased, particularly as urban lifestyles have become more prevalent (Molina Martínez, 2000; Castro-Lara et al., 2014). For city-dwelling Mexicans, quelites are commonly associated with poverty which is why they prefer to replace them with more "Western" vegetables. However, certain urban consumers still appreciate quelites as condiments in soups, stews, or quesadillas (Altieri, 2016; Casas et al., 2016b; Vibrans, 2016). In more rural areas, quelites remain important complementary foods and are significant dietary sources of vitamins and minerals (Molina Martínez, 2000; Román-Cortés et al.,

Table 1. Promising quelite species presented in this section, by their sequence of appearance in the text

Popular Name	Scientific Name	Plant Family	Plant Type	Preferred Climates	Distribution	Typical Production Systems	References
Papalo	*Porophyllum ruderale var. macrocephalum* (DC.) Cronq.	*Asteraceae*	Annual herbaceous plant	Temperate, tropical, arid, and semiarid	Mesoamerica (occasionally other parts of the Americas)	Milpa (corn associated with other crops), cultivated	Katz and Hémond (2014); Rzedowski and de Rzedowski (2015); Mapes and Basurto (2016); Encyclopedia of Life (2022); USDA (2022)
Huazontle	*Chenopodium berlandieri* ssp. *nuttaliae*	*Amaranthaceae*	Annual herbaceous plant, erect and odorless	Template and subtropical	Mesoamerica (occasionally South America)	Milpa, cultivated	Carrillo-Ocampo and Engleman (1994)
Chaya	*Cnidosculus aconitifolius* ssp. *Aconitifolius*	*Euphorbiaceae*	Semi-perennial and semi-woody plant; leaves are irritant	Tropical and subtropical	Mesoamerica (occasionally Caribbean)	Around diverse cropping systems, cultivated	Stephens (1994); Scheman and Conde (2001); Parra-Tabla et al. (2004); Torres-González and García-Guzmán (2014); Ebel et al. (2019)
Surinam purslane	*Talinum fruticosum* Juss.	*Portulacacea*	Herbaceous, succulent, erect, and perennial	Tropical	Mesoamerica and South America	Orchards and vineyards	Amaya et al. (2018); da Trindade Lessa et al. (2021); Albuquerque et al. (2022)
Cobblers pegs	*Bidens pilosa* L.	*Asteraceae*	Annual or perennial herbaceous	Subtropical, tropical, and template	Caribbean, Southern United States to South America	Diverse monocultures (e.g., corn, soy, canola, avocado, coffee, pineapple)	Bartolome et al. (2013); Devia (2018); Arévalo et al. (2021)
Horse purslane	*Trianthema portulacastrum* L.	*Aizoaceae*	Herbaceous, succulent, and prostrate	Subtropical, tropical, and arid	Caribbean, Southern United States to South America	Diverse monocultures (e.g., soy, pigeon pea, corn, rice, cotton, potato, tomato, melon, onion, garlic)	Shivhare et al. (2012); Prakash et al. (2019); Guerra et al. (2020); Mubeen et al. (2021); Fakhr et al. (2022)
Climbing dayflower	*Commelina diffusa* Burm. F.	*Commelinaceae*	Herbaceous and creeping	Tropical and subtropical	Caribbean, Southern United States to South America	Gardens, orchards, grains, and cereals	Mas and Lugo-Torres (2013); Berríos-Ortiz (2018)

(continued)

Table 1. Promising quelite species presented in this section, by their sequence of appearance in the text *(continued)*

Popular Name	Scientific Name	Plant Family	Plant Type	Preferred Climates	Distribution	Typical Production Systems	References
Virginia pepperweed	*Lepidium virginicum* L.	*Brassicaceae*	Annual herbaceous plant	Template, tropical, and subtropical	Caribbean, North America	Vegetable cropping systems (especially *Brassicaceae*)	Schery (1953); Berríos-Ortiz (2018)
Purslane	*Portulaca Portulacacea* L.	*Portulacacea*	Annual herbaceous succulent plant	Template, tropical, and subtropical	Across the continent	Gardens, less in grains and cereals, cultivated	Danin and Reyes-Betancort (2006)
Common lambsquarters	*Chenopodium album* L.	*Amaranthaceae*	Annual herbaceous plant	Template, subtropical	Across the continent	Diverse annual crops, orchards, and nurseries	Cabrera and Zardini (1978); Poonia and Upadhayay (2015)
Dandelion	*Taraxacum officinale* L.	*Asteraceae*	Perennial herbaceous	Template	Across the continent	Diverse crops	Cabrera and Zardini (1978)
Narrowleaf plantain	*Plantago lanceolata* L.	*Plantaginaceae*	Perennial herbaceous	Template and subtropical	Across the continent	Cereals, pastures, gardens, and orchards	Cabrera and Zardini (1978)

2018), and in the case of amaranths, even of proteins (Altieri, 2016). In specific regions and during holidays such as Christmas, quelites have become a core part of the Mexican diet (Mapes and Basurto, 2016). Among the most used quelites in different parts of Mexico are papalo, huazontle, and chaya.

Papalo

Papalo is one of the 6 species of *Porophyllum* spp. that are consumed in Mesoamerica (Vázquez, 1991; Katz and Hémond, 2014; Aguirre-Dugua et al., 2022; Encyclopedia of Life, 2022). In Mexico, it is also known as *papaloquelite, hierba de venado*, *tlapanche*, or *chepiche* (Vázquez, 1991). Outside Mexico, *yerba porosa* refers to all *Porophyllum* species (United States Department of Agriculture [USDA], 2022). Inside Mexico, white papalo is distinguished from purple papalo by the color of their leaves and stems (Casas et al., 2016a). Both types are eaten in the south and center of the country (Vázquez, 1991). Their production in monoculture is rare (Vázquez, 1991; Mapes and Basurto, 2016). Papalo is consumed more as a condiment than a vegetable (Vibrans, 2016). Its leaves are eaten raw or cooked in stews, for example, with beans (Katz and Hémond, 2014; Aguirre-Dugua et al., 2022) and it is an essential ingredient of the typical *cemitas* sandwiches of Puebla. A case study from central Mexico indicates an annual consumption of 2.74 kg of papalo per household (Casas et al., 2016b). There is also evidence of traditional medicinal use of specific varieties of *P. ruderale* in Argentina and Colombia to cure digestive disorders and rheumatism. The species is also an ingredient of *llajwa*, a popular spicy sauce from Bolivia (Carrizo et al., 2002; Pandales, 2017).

Huazontle

The genus *Chenopodium* spp. was one of the most important sources of plant protein in precolonial cultures throughout the Americas. There is evidence of its cultivation in the north and south of the continent (Poonia and Upadhayay, 2015; Mueller et al., 2017). Huazontle, red chia, and *quelite cenizo* are 3 varieties of *C. berlandieri*. ssp. *nuttaliae*, and all are common quelites in Mexico (Carrillo-Ocampo et al., 2009). The name huazontle is derived from the Nahuatl *huautli* for "amaranth" and *tzontli* for "hair" (Kistler and Shapiro, 2011). The subspecies is native to North America and shares important characteristics with quinoa (Fant De Gordon, 1998). Since precolonial times, huazontle has been consumed in Mexico (Kistler and Shapiro, 2011). It is a rare quelite collected and cultivated for the consumption of its inflorescences (Mapes and Basurto, 2016). Immature seeds are consumed boiled and stewed in different recipes with eggs or omelets (Carrillo-Ocampo et al., 2009; Figueredo-Urbina et al., 2022). Huazontle contains high levels of proteins and unsaturated fatty acids and nutritional properties that have attracted the interest of researchers (Barrón-Yánez et al., 2009). The plant is also gluten-free (Kistler and Shapiro, 2011) and rich in antioxidants (Lazo-Vélez et al., 2016).

Chaya

Chaya is a fast-growing shrub whose use and management in Guatemala, Belize, southern, and southeastern Mexico date back to the precolonial period (Ross-Ibarra and Molina-Cruz, 2002). There is no large-scale cultivation, and chaya is considered a semi-domesticated plant. In addition to wild chaya, there are 4 varieties whose degree of domestication varies: "Chayamansa," "Redonda," "Estrella," and "Picuda" (Stephens, 1994; Méndez Aguilar et al., 2021). Throughout the Yucatan Peninsula, this quelite is common, especially in the family gardens of Maya peasants. Chaya is typically associated with perennial plants and a variety of both cultivated and wild herbs. It is utilized as a source of food for humans and animals, as well as for medicinal purposes (Ebel et al., 2019; Martínez et al., 2020). The plant grows well in diverse soils, even with low fertility (Ross-Ibarra and Molina-Cruz, 2002). Although chaya leaves are occasionally consumed raw, they usually require cooking before ingesting them due to their high hydrogen cyanide content (González-Laredo et al., 2003; Castro-Lara et al., 2014). With a protein content of 57 g kg^{-1} of fresh leaves, chaya is one of the most nutritious terrestrial vegetables. In addition, the plant is rich in vitamin A, vitamin C, calcium, potassium, iron, and antioxidants (Aguilar-Ramírez et al., 2000; Insuasty Santacruz et al., 2013). Its large mature leaves are used to wrap other foods, while the young leaves and apical shoots are consumed (Loarca-Piña et al., 2010). Chaya is a common ingredient of the Maya diet, although it currently does not have a good reputation within the local communities (**Box: Chaya: U janal óotsilo'ob/food of the poor**). In addition, chaya is sometimes used as an ornamental plant, living fence, forage, and in traditional Mayan medicine to cure diabetes, kidney problems, arteriosclerosis, gastrointestinal problems, and high cholesterol (Kuti and Torres, 1996; García-Rodríguez et al., 2014).

Quelites of tropical South America

While the term "quelites" is primarily used in Mesoamerica, the concept is known practically worldwide. The examples of "quelites" in different climate zones of the Americas will be discussed, starting with tropical South America. In this region, diverse weeds are utilized for food, medicine, and various other purposes, holding social, cultural, and economic significance. Numerous *arvenses* are associated with agroecosystems in tropical South America, and many of them are found across different countries. Therefore, mentioning a plant species in the context of its use in a particular region or country does not imply that its presence and uses are exclusive to that area.

In the tropics of Venezuela, different quelites are consumed, among them the fruit of the wild cucumber (*Cucumis anguria* L.), the tuber of the *mapuey* or Indian yam *(Dioscorea trífida* L.), stinging nettle leaves (*Urtica dioica* L.), and the seeds, stems, and leaves of spleen amaranth (*Amaranthus dubius* Mart. ex. Thell.). Those species are often disregarded as weeds, but rural and economically marginalized individuals eat them

Box: Chaya: U janal óotsilo'ob/food of the poor

A series of *tsikbaló'ob* (conversations through time and space in the Maya language) among Maya women and men from various communities in the so-called Maya Area of Quintana Roo, Mexico, indicates that chaya is by no means a favorite dish among this population. Several interlocutors agree that it is socially disregarded and only consumed out of necessity. Lidia (50 years old) comments: "Chaya is the last option . . . if there's no money, no meat, no beans, nothing, and you're in a tight spot . . ."

Maya people call it *u janal óotsilo'ob*, food of the poor. It represents poverty. People who eat chaya are considered the poorest in the community and the lowest in social status. Its consumption causes shame. Ricardo (21 years old) narrates the following: "When I've been at my girlfriend Maria's family's house, they always gladly invite me to eat, except when they cook chaya; it's like they feel embarrassed to invite me, like they save the food . . . until the last moment Maria (20 years old) tells me, 'Oh, Ricardo, how embarrassing, I invite you to eat, but only *chéen chaaya!*'" *Chéen* in Maya is "approximate," "although," or "oh well."

Jorge (45 years old) comments on this: "Feeling ashamed of having eaten chaya is caused by the criticism or mockery someone receives for not having the money to buy beef, pork, or chicken. Sometimes, it's not just embarrassing to say, 'I ate chaya today,' but it is even more embarrassing for other people to see that you eat chaya at home."

Contrary to what is believed and represented in the commercialization of Mayan culture for tourist purposes, chaya is not an archetype of Mayan food but a sociocultural element that builds and transforms power and prestige relationships among people in Mayan communities. It simultaneously defines identities that hinder the generation of feelings of solidarity and cohesion.

frequently (Carmona et al., 2008; Olivares and Peña, 2009; Rutto et al., 2013).

In Colombian markets, various *quelites* and underutilized species are found, including plants for leaf consumption, such as watercress (*N. aquaticum*), cobblers pegs, dandelion, common sowthistle, purslane, guasca (*Galinsoga parviflora* Cav.), and guaca [*Spilanthes americana* (Mutis) Hieran] (Molina Martínez, 2000; Giraldo Quintero et al., 2015). *Guaca* and *guasca* are ancestral foods inherited from the native nations of South America. Watercress and dandelion are primarily used for medicinal purposes, although their leaves are also consumed in salads, soups, and other dishes. The seeds of *epazote*, called *paico* in Colombia, are utilized for their vermifuge effect (Arbelaez, 1957).

In Ecuador, the leaves of mosquera (*Croton elegans* Kunth) are used to enhance wound healing; lemongrass [*Cymbopogon citratus* (DC.) Stap] to prepare medicinal beverages, the tree fern or *yuyo* [*Hypolepis hostilis* (Kunze) C. Presl] in salads or with rice; the fruit of the *chontaduro* (*Bactris gasipaes* Kunth) as food for humans and animals; and the fruit of *porotón* (*Cynophalla flexuosa* J. Presl) primarily to feed poultry. Rural dwellers, especially those with scarce economic resources, frequently consume quelites (Culqui Aimacaña, 2019).

Other *quelites* popular in tropical regions of South America are Chinese violet (*Asystacia gangetica* T. Anderson), lilac tassel flower (*Emilia sonchifolia* DC. ex Wight), yellow sorrel (*Oxalis corniculata* L.), and balloon cherry (*Physalis angulata* L.; Martin et al., 1998; Plants for a Future, 2013; Lazo-Vélez et al., 2016).

Surinam purslane

Surinam purslane is native to South America and is usually found up to 1,000 m above sea level (Herrera et al., 2015; Pasquini et al., 2018). Its flowers are melliferous (Nya and Eka, 2015; Tejeda-Rico et al., 2019). It adapts well to diverse soils and tolerates drought and salinity (Martin et al., 1998; Herrera et al., 2015). Surinam purslane is a host of the cucumber mosaic virus (Adediji, 2019). It is frequently used as food, for its medicinal effects (Rapoport et al., 2009; Oliveira et al., 2019), and as an ornamental (Kumar and Prasad, 2010). Its leaves are rich in calcium, magnesium, potassium, vitamins C and E, beta-carotene, omega-3 fatty acids, fiber, and nitrogen compounds (Ezekwe et al., 2013). In tropical regions of South America and Africa, the young leaves, sprouts, and flowers of both wild and cultivated Suriname purslane are commonly included in the diet. These plant parts may be eaten raw, in soups, or after light steaming. Cooking reduces the concentration of oxalates, but excessive cooking can render the plant mucilaginous (Tindall, 1983; Martin et al., 1998; Ameh and Eze, 2010; Ezekwe et al., 2013). In Brazil, Surinam purslane is marketed and eaten with beans, shrimp, sausage, stewed with eggs or shrimps, or *sautéed* with seasoning (Oliveira et al., 2019; Da Trindade Lessa et al., 2021). The plant is a good source of carotene and lycopene, saponins and allicins, phytosterols, and quercetin (Ikewuchi et al., 2017). Traditionally, Surinam purslane serves to treat diabetes, as well as cardiovascular and hepatic diseases, to improve memory, reduce cholesterol, prevent cancer, and as a laxative (Ameh and Eze, 2010; Liang et al., 2011; Ezekwe et al., 2013). Additionally, it serves as poultry feed (Nworgu et al., 2015).

Cobblers pegs

Cobblers pegs (**Figure 1**) is native to South America and thrives in wet and warm places under full sunlight. It adapts to soils with a pH between 4 and 9, fertile or not, and even to saline soils (Bartolome et al., 2013). It is a competitive and allelopathic *arvense* (Arthur et al., 2012; Borella et al., 2017; dos Santos et al., 2022). Cobblers pegs may be used for nutrition and medicinal purposes for cattle and poultry (Chang et al., 2016; Yang et al., 2019). Cobblers pegs is also a nutritional and medicinal plant for humans. For food use, tender leaves and branches can be conserved by drying them for future use; fresh leaves and sprouts may be cooked for salads and salsas (Alikwe et al., 2014; Mboya, 2019). The leaves are rich in antioxidants, phosphorus, zinc, manganese, and boron. When dried, they contain nearly 25% protein. For medicinal purposes, the plant holds fatty acids, sterols, phenols, phytosterols, flavonoids, and terpenes (Chiang et al., 2004). Cobblers pegs is used in traditional medicine

Figure 1. Cobblers pegs, *Bidens pilosa* (U.S. Department of Agriculture Natural Resources Conservation Service [USDA NRCS], 2022). Cobblers pegs is a member of the *Asteraceae* family, native to South America, and a quelite with uses beyond its nutritional value.

for the treatment of infections, indigestion, hypertension, diabetes, and obesity. Typically, the leaves are utilized to prepare infusions or consumed in a powdered form (Liang et al., 2011). Since cobblers pegs is an accumulator of chromium, it is not recommended to eat it when grown in soils polluted with heavy metals or with a naturally high content of chromium (Kissanga et al., 2021). Conversely, in soils with excess heavy metals, this plant could contribute to bioremediation (Li et al., 2019; Dai et al., 2021).

Horse purslane

Horse purslane is native to South America but widely distributed throughout the American tropics and subtropics. It adapts to diverse environments, from arid and saline regions to pluvial conditions (Dai et al., 2021). It has been reported that the plant strongly competes with crops and reduces their yield by up to 60% (Mubeen et al., 2021; Fakhr et al., 2022). Horse purslane is an edible and medicinal plant (Berríos-Ortiz, 2018). Its foliage is rich in fiber, calcium, magnesium, nitrogen, iron, zinc, phosphorus, vitamins C and B3, and therefore considered a good source of nutrients for humans and animals (Prakash et al., 2019; Montelongo et al., 2021). The leaves must be eaten while tender, as old leaves (as well as seeds) may cause diarrhea and paralysis in humans and animals (Shivhare et al., 2012). Horse purslane contains alkaloids, sterols, flavonoids, glycosides, saponins, and various pigments and essential oils that confer this plant's medicinal properties for wound healing, pain, and fever reduction, protection of the liver and the kidneys, antioxidant, antifungal, anti-inflammatory, and vermifuge. It is also used to treat asthma, bronchitis, sore throat, jaundice, rheumatism, edemas, and stones in the urinary system (Ahmad et al., 2000). In Colombia, Brazil, and Peru, horse purslane is considered a melliferous plant (Tejeda-Rico et al., 2019; de Oliveira et al., 2020; Correa Seminario, 2021), providing a crucial ecosystem service.

Quelites of the Caribbean

In the Caribbean, quelites are called *buenezas*[3] by some. This term may also be used for medicinal plants. Several species of *Amaranthus* are particularly popular food sources throughout the region. For instance, in Trinidad and Tobago, their use is promoted to support local food security (Facciola, 1990; Ramdwar et al., 2017). *Amaranthus viridis* L. is an important quelite in Jamaica, where it is called callaloo (Clarke-Harris et al., 1998). Also in Jamaica, turkey berry (*Solanum torvum* Sw.) is boiled to be used as a leafy green and also consumed in soups and stews (Facciola, 1990).

In Cuba, vegetative organs of several quelites are eaten, including pigweed (*A. dubius*), purslane, cat's whiskers [*Gynandropsis gynandra* (L.) Briq.], and glossy nightshade (*Solanum americanum* Mill.); the seeds of *Senna obtusifolia* (L.) H. S. Irwin & Barneby and *S. occidentalis* (L.) Link have been used as a substitute for coffee (Volpato and Godinez, 2006; Pasquini et al., 2018). Other quelites such as saltbush or *abanico* (*Atriplex* spp.), yellow nutsedge (*Cyperus esculentus* L.), which produces edible tubers known as *chufa*, bitter gourd (*Momordica charantia* L.), and common sowthistle are also eaten in Cuba (Fuerzas Armadas Revolucionarias y Academia de Ciencias de Cuba, 1987).

In Puerto Rico, at least 53 species of quelites are used, according to a case study about the most common *arvenses* on organic farms (Berríos-Ortiz, 2018). In this research, it was found that boiling the leaves of quelites such as pigweed, purslane, and horse purslane (known as *peseta* in Puerto Rico) reduces their content of antinutritional oxalates (Berríos-Ortiz, 2018). The study involved interviews with 45 adults over 65 years, of which 14 mentioned purslane, 2 clover, and 2 climbing dayflower as regular food sources. Other common quelites identified in this study were *cundeamor* (*Momordica charantia* L.), chicory [*Launaea intybacea* (Jacq.) Beauverd.], wild maracuja (*Passiflora foetida* L.), nutsedge (*Cyperus* spp.), and sorrel (*Oxalis* spp.).

3. "Good ones," as opposed to *malezas* ("bad ones") for weeds.

Figure 2. Climbing dayflower, *Commelina diffusa* (USDA NRCS, 2022). Climbing dayflower is a quelite widely used in North America and the Caribbean.

The Caribbean is one of the most susceptible regions to extreme climate events and is exposed to food cost fluctuations and, in consequence, depends considerably on food imports (Dorodnykh, 2017). The use of *quelites* may serve as an important to promote food sovereignty in that region.

Climbing dayflower

In the Caribbean, climbing dayflower (**Figure 2**) is usually found on disturbed wet soils, crop fields, and in forests (Berríos-Ortiz, 2018). Banana and plantain growers consider it a weed for its high competitiveness and as host of nematodes and phytopathogenic viruses (Baker and Zettler, 1988; Inserra et al., 1989; Hillocks, 1998; Quénéhervé et al., 2006; Isaac et al., 2007; Olivera, 2010; Berríos-Ortiz, 2018). Climbing dayflower and other *Commelina* species are eaten in different regions of the world, for instance, in Brazil and India (Hanazaki et al., 2006; Berríos-Ortiz, 2018). In Mexico, the stems of climbing dayflower and *C. tuberosa* L are used as food (Olivera, 2010). Likewise, in the United States, the leaves and stems of climbing dayflower are consumed boiled or raw (Fernald and Kinsey, 1943; Schery, 1953; Kendler and Pirone, 1989; Berríos-Ortiz, 2018). In Puerto Rico, the plant is often called *cohitre*, and its leaves are eaten in salads (Núñez Meléndez, 1982; Berríos-Ortiz, 2018; Peduruhewa et al., 2021). There is no evidence of toxicity of climbing dayflower (Wansi et al., 2014; Berríos-Ortiz, 2018; Rahman et al., 2021). According to Núñez Meléndez (1982), in Puerto Rico, it is utilized as a diuretic and to mitigate discomfort in the digestive system.

Virginia pepperweed

Virginia pepperweed (**Figure 3**), also known as *mastuerzo* in Puerto Rico, is considered a competitive plant in diverse crops. Across the Caribbean, its usual habitats include disturbed, wet, and well drained soils. The plant is also commonly found growing alongside roads and crop fields (Mas and Lugo-Torres, 2013). Virginia pepperweed is occasionally cultivated in cooler climates, mainly in Europe, and used for

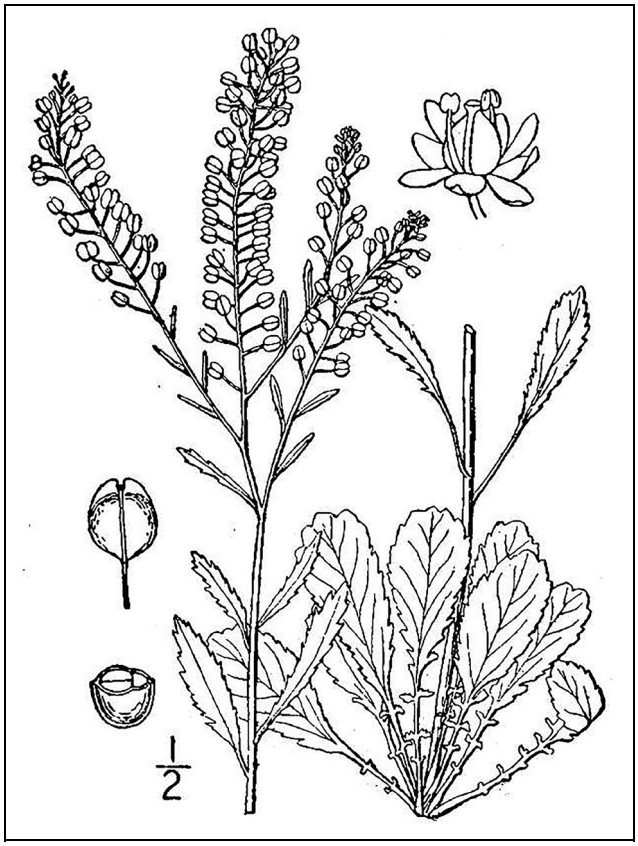

Figure 3. Virginia pepperweed, *Lepidium virginicum* (USDA NRCS, 2022). Virginia pepperweed is one of the most popular quelites in Mexico and Puerto Rico.

salads (Schery, 1953; Berríos-Ortiz, 2018). Historically, its leaves were also consumed as leafy greens in North America (Fernald and Kinsey, 1943; Schery, 1953; Berríos-Ortiz, 2018). The seeds and immature pods of Virginia pepperweed have a taste similar to bell pepper and can be added to various dishes to enhance their flavor (Kunkel, 1984; Facciola, 1990; Meuninck, 2018). Young leaves are also edible, tasting similar to mustard but more bitter (Meuninck, 2018). In Cuba, the leaves of Virginia pepperweed are popular in salads or boiled (Kunkel, 1984; Facciola, 1990; Volpato and Godinez, 2006; Berríos-Ortiz, 2018). In Mexico, the plant ranks among the 10 most consumed quelites in Tarahumara communities, where the leaves, flowers, and fruits are cooked with beans and eggs or steamed (Bye, 1981; Vibrans, 2016; Manzanero-Medina et al., 2020). In Cuba and Puerto Rico, Virginia pepperweed is also part of a diuretic and hypoglycemic beverage (Núñez Meléndez, 1982), and Haitian communities in Camagüey, Cuba, use it to improve digestion (Volpato and Godinez, 2006).

Purslane

Purslane, a cosmopolitan species (Egea-Gilabert et al., 2014), holds a rich history as an archaeophyte, consumed by humans for millennia (Chapman et al., 1973; Simopoulos et al., 1992). Cultivated for over 2,000 years in places like India and Iran (Duke, 2008), it is revered in Chinese folklore as "the vegetable for a long life" (Zhu et al., 2010; Wanyin et al., 2012). Today, its cultivation

and consumption span the globe, including European countries like France, Denmark, and the Netherlands (Facciola, 1990; Grosskinsky and Gullick, 2000). Purslane's nutritional properties were demonstrated in multiple studies (Bianco et al., 1998; Guil-Guerrero and Rodríguez-García, 1999; Liu et al., 2002; Gonnella et al., 2010; Besong et al., 2011; Berríos-Ortiz, 2018), positioning it as the richest source of omega-3 fatty acids among leafy green vegetables (Simopoulos et al., 1995). Its profile also includes high levels of proteins, soluble polysaccharides, vitamins, minerals, alpha-linoleic acid, and alpha-tocopherol (Simopoulos et al., 1992), coupled with notable antioxidant activity (Odhav et al., 2007). However, purslane also contains antinutritional compounds like oxalates and nitrates, which vary among cultivars, seasons, and harvest times (Kaşkar et al., 2008; Lara et al., 2011; Egea-Gilabert et al., 2014). Specific purslane varieties find purpose in human and animal consumption in tropical South American regions. There is also evidence of commercial cultivation in Mexico's *chinampas* (Ebel, 2020; Montoya-García et al., 2023). On the Caribbean coast of Colombia, Afro-descendent communities value purslane as an edible wild plant (Pasquini et al., 2018). Meanwhile, in various Caribbean regions, purslane is perceived as a quelite (Cruttwell-Mcfadyen and Bennett, 1995; Santos et al., 1997). Some Puerto Rican farms deliberately preserve spontaneously growing purslane during weeding, utilizing it as a living soil cover in tomato crops. Some Puerto Rican growers selectively harvest and market purslane (Guerrero et al., 1999; Berríos-Ortiz, 2018).

Quelites of temperate South America

In the temperate region of South America, more than 500 species of quelites have been recorded, many of them of great nutritional value. For example, Rapoport et al. (2009) describe 237 species of edible quelites that are abundant in the Southern Cone. However, the abundance and diversity of quelites are lower than correspondent patterns observed in tropical regions of Mesoamerica and the Caribbean. For example, a comparative study of quelite communities between Coatepec (Mexico) and Bariloche (Argentina) indicates a total of 43 species of quelites present in the urban, peri-urban, and rural environments of Mexico, but only 32 species sampled in the Southwest of Argentina (Díaz-Betancourt et al., 1999). Likewise, the productivity of quelites is relatively low in the temperate region of South America. However, in both Mexico and Argentina, the same plant organs of specific quelites are consumed, with the leaves and seeds being the most used among annual plants and the roots, including bulbs and rhizomes, the most used sections of the perennial quelites.

Among the native peoples of Argentina, TEK, as well as the use of quelites for food, medicinal, and cultural purposes, is broad and deep. These have been passed down from generation to generation over time. Arenas (2012) compiles a large amount of information on the different uses of vegetation by the Mocovíes, Tobas, Matacos, and Wichís, among other groups that inhabit the arid and semiarid sections of Northwestern Argentina. In turn, Ladio and Lozada (2004) and Estomba et al. (2006) summarize the use and nutritional and medicinal knowledge of quelites among the Mapuche communities of the Patagonian region. For the Mapuche of northwest Argentine Patagonia, collecting and using quelites is a deep-rooted practice, where locals, regardless of age, recognize 64 species of medicinal quelites and 24 species of edible quelites.

Despite this vast knowledge, the majority of the urban and peri-urban population of the region is unaware of the existence of quelites and groups them under the generic term of "weeds," species of no value that must be eliminated from the landscape. However, this trend seems to be reversing: A recent survey of urban horticultural fairs in southern Argentina indicated a total of 29 species of quelites, locally known as "edible weeds," marketed for human consumption or medicinal use (Ladio et al., 2013). Similarly, Longo Blasón et al. (2022) determined a total of 186 ethnospecies and 315 local foods regularly marketed at horticultural fairs in southwestern Argentina. These results exemplify the potential of quelites to increase food sovereignty, promote the local economy, and stimulate the social fabric in rural and urban areas of South America. Among the quelites commonly used in the temperate region of South America are the common lambsquarters, the dandelion, and the narrowleaf plantain.

The common lambsquarters

The common lambsquarters (**Figure 4**) is known as quelite, *yuyo blanco*, and *quingua del campo*, among other names. The leaves on the upper part of the stems are rhomboidal-lanceolate and waxy, with a whitish layer on the lower part, from which it receives its name (Cabrera and Zardini, 1978). Widely distributed, it colonizes soils rich in nitrogen, especially in annual crops, fruit forests, nurseries, abandoned land, and the sides of roads and railways. Due to its high ability to compete with crops and its wide distribution, the common lambsquarters has been cited as one of the most problematic and difficult weeds to manage. Despite this, given its high content of minerals, fibers, vitamins, and essential fatty acids, the lambsquarters continues to be used as food and medicine (Poonia and Upadhayay, 2015). The leaves, tender stems, and inflorescences can be consumed raw or cooked, following the recipes used to prepare spinach or Swiss chard, although in moderation, due to their high oxalic acid content (Poonia and Upadhayay, 2015). The seeds can be used to replace cereals or to prepare flour. The leaves, flowers, and tender parts can be dried and preserved for the winter (Rapoport et al., 2009). There is also evidence of its medicinal use, even outside the American continent; for example, in China and India, where the common lambsquarters serves as a diuretic, laxative, sedative, anti-inflammatory, and antiparasitic traditional medicine (Ksouri et al., 2012).

Dandelion

The dandelion (**Figure 5**) is of Eurasian origin, widely distributed along roads and pastures, meadows, sowed

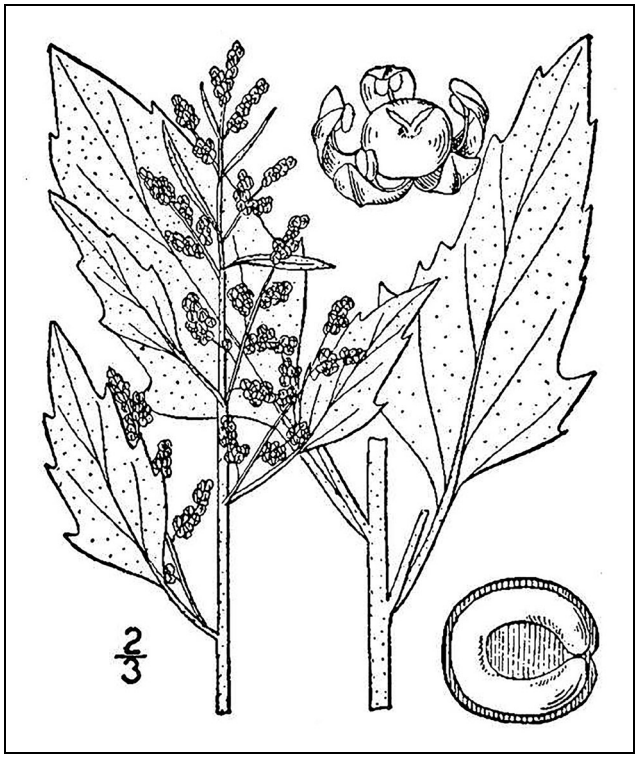

Figure 4. The common lambsquarters, *Chenopodium album* (USDA NRCS, 2022). *Amaranthaceae*, such as lambsquarters, have a long pre-Columbian history as sources of food throughout the American continent.

Figure 5. Dandelion, *Taraxacum officinale* (USDA NRCS, 2022). The dandelion is one of the few quelites whose edible use is known in a broad cross section of society.

crops, and gardens of the temperate regions across the planet. It is locally known as *achicoria amarga*, *amargón*, *cerraja*, or *lechuguilla.* The dandelion undergoes a leaf loss during winter, only to resprout vigorously in the spring. However, in milder climates, it often persists and can even continue flowering throughout the year (Cabrera and Zardini, 1978). The young and tender leaves of the dandelion can be consumed fresh in salads, while the mature ones, being more bitter, usually require cooking. The roots can be dried at 45°C, roasted for 30 min at 150°C, and ground. The resulting powder is used as a substitute for coffee,

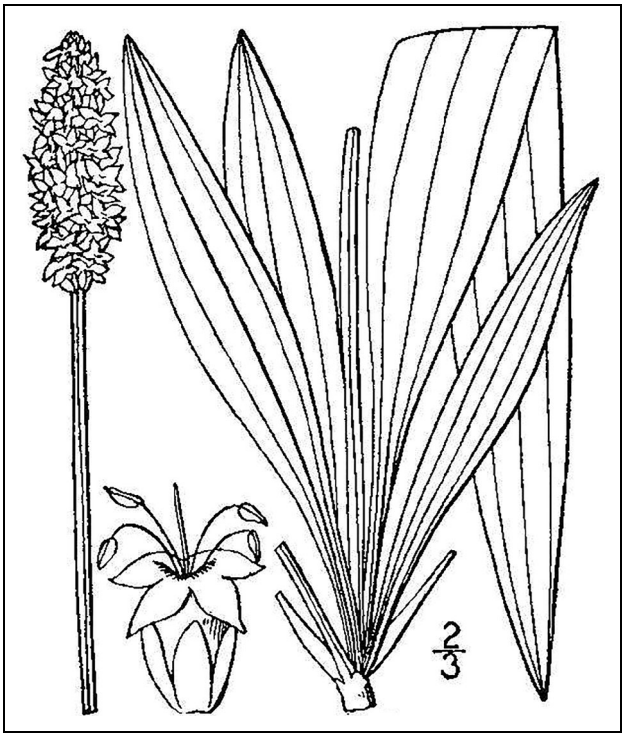

Figure 6. *Plantago lanceolata* (USDA NRCS, 2022).

which it resembles in flavor, color, and aroma. Rapoport et al. (2009) indicate that immature flower buds are consumed raw, steamed, cooked, fried, or preserved, while mature flowers can be used to prepare alcoholic beverages. Plants of the genus *Taraxacum* and *T. officinale*, in particular, have been traditionally used as sources of medicine. The therapeutic value of *Taraxacum* is attributed to the presence of sesquiterpenes, saponins, phenolic compounds, flavonoids, and sugars, among others (Martinez et al., 2015). For example, Mapuche communities in the Argentine Patagonia plant dandelion in their gardens or collect them in semi-wild lands, not only as a food source but also for their therapeutic uses (Eyssartier et al., 2011). In turn, Wirngo et al. (2016) point out that dandelion has the potential to prevent and treat type 2 diabetes, but they clarify that more studies are required in this regard. A review of the phytochemical and antimicrobial activity of the genus *Taraxacum* highlights that, while traditional use attests to the healing potential of these plants, there remains a scarcity of clinical studies delving into their pharmacological activity and biosafety (Sharifi-Rad et al., 2018).

The narrowleaf plantain

The narrowleaf plantain, *plantén*, *llantén*, or *llantén menor* (**Figure 6**) is an edible plant of the *Plantaginaceae* family with medicinal use. Native to Europe, it can be found in humid soils, abandoned land, roadsides, crops, gardens, grazing meadows, embankments, and ditches (Cabrera and Zardini, 1978). The leaves can be consumed raw or cooked like spinach, alone or mixed with other plants. Rapoport et al. (2009) indicate that the seeds are easy to collect and shell and are used to make flour. However,

Drava et al. (2019) observe that, in highly contaminated areas, such as mines or industrial smelting plants, narrowleaf plantain can accumulate toxic metals such as cadmium or lead in concentrations up to 15 times higher than in rural areas. In cities, the concentration of lead can be 3 times higher than in rural areas; therefore, it is recommended not to collect plants in potentially contaminated sites. In traditional medicine from different countries, the leaves, flowers, and fruits of the narrowleaf plantain are used for anti-inflammatory and healing purposes, possibly due to their high antioxidant content (Vanzani et al., 2011); for example, the Mapuche communities of Argentine Patagonia (Ladio et al., 2007). In Ethiopia, where this species is used to treat wounds, Fayera et al. (2018) determined that *P. lanceolata* extracts have antibacterial and antifungal activity. Likewise, in Turkey, raw leaves are used to heal wounds, cuts, and inflammations (Kültür, 2007).

Policies and practices to promote agrobiodiversity beyond crops

Policies and practices in favor of quelites are usually part of strategies that benefit agrobiodiversity in general. It is difficult to imagine a measure to rescue quelites without considering concepts such as polycultures or the use of landraces. We detected 7 areas that—in our opinion—activists, decision-makers, educators, and politicians should emphasize to achieve significant use and revitalization of quelites.

1. Awareness and education: It is essential to raise awareness about the importance of agrobiodiversity and quelites as part of sustainable agroecosystems, healthy and diverse diets, as well as for resilient peasant cultures. Educational programs implemented and promoted in formal and rural schools, universities, and communities should inform about the nutritional, cultural, and environmental benefits of quelites, how to manage them, and how to include them in the daily diet.
2. Research and development: We suggest promoting research and the development of appropriate technologies for the cultivation, conservation, and use of quelites. This includes studies on their nutritional properties, sustainable cultivation methods (whether in poly- or monoculture), as well as preservation techniques and processing. Due to the significance of TEK for this topic and for peasant and Indigenous food cultures in general, we believe that such research should be mainly participatory, including producers and communities in each project step.
3. Biodiversity Conservation: To advocate for the preservation of quelites, it is crucial to implement policies and initiatives directed toward the conservation of biodiversity. This encompasses the protection of both wild ecosystems and agroecosystems, recognizing them as invaluable genetic resources for the existing and future quelite varieties. This approach entails the establishment of protected areas, the encouragement of sustainable agricultural practices, the preservation of native seeds, the establishment of germplasm banks, the judicious use of agrochemicals, governmental oversight with penalties for excessive agrochemical use, the endorsement of independent peasant schools, and the incorporation of a curriculum that emphasizes traditional agriculture in higher education agriculture programs. We suggest the creation of policies that evaluate plants by their usability (for ecosystems and humans) and do not categorically deprecate select species as "weeds" or "invasive plants," while not ignoring the challenges that weeds can cause in agriculture.
4. Access to seeds and genetic resources: It is important to guarantee unlimited access to quelites seeds and other germplasm for farmers to promote the conservation and exchange of local varieties and the respective traditional knowledge. This can be achieved by creating community seed banks, promoting seed exchange fairs, and protecting farmers' rights over their genetic resources.
5. Support for traditional producers: Agricultural policies and rural development programs must support local producers who grow quelites and other species contributing to agrobiodiversity. This may include land tenure laws that favor sustainable and traditional production, subsidies and other economic incentives; technical training (if necessary); equitable access to markets and food processing sites (if desired); adequate infrastructure (inside and outside the fields); protection of lands and markets against investments by actors that do not favor traditional farming; measures for a revitalization of traditional and local cuisines; social programs in the respective communities, supporting the livelihoods of producers, for example, in areas such as health and education; and, in general, measures to achieve equitable and sustainable food systems. Recognizing that today, Indigenous communities predominantly safeguard agrobiodiversity and quelites, we advocate for all policies that support the continuity of these cultures.
6. Diversified diets: Quelites and agrobiodiversity can be promoted through gastronomy and tourism, highlighting their culinary and cultural value. This involves traditional quelites-based dishes in restaurants, gastronomic fairs, and culinary events, as well as the creation of tourist routes that highlight the diversity of local products.
7. Certification policies: We suggest that the establishment of certification policies for agroecological products can help urban consumers identify foods produced sustainably and equitably.

Conclusions

Agroecological literature is rich in evidence that demonstrates the essential role of agrobiodiversity for the

resilience of agroecosystems and food systems in the face of challenges such as climate change. The diversity that characterized agriculture in its beginnings has been lost in the last 100 years due to the industrialization of the food system, which has resulted in a reduction in genetic diversity on the farm and, consequently, reduced nutritional diversity. However, diversified agroecosystems still exist and contribute significantly to food security and sovereignty in many parts of the world, especially in communities dominated by traditional and subsistence agriculture. The management of agrobiodiversity in these communities depends on the empirical transmission from generation to generation of TEK. However, this transmission is currently decreasing due to different factors, including the emigration of young people from rural communities or the conversion of traditional to conventional agroecosystems. Today, there are important movements to rescue this diversity, commonly led by peasant organizations. Many of these movements focus on a greater diversity of established crops. Yet only a few of them also consider the agrobiodiversity associated with crops. In this article, we focus on these plants, specifically, on quelites. Many *arvenses* are currently perceived as "weeds" and, consequently, subject to endless applications of herbicides. We believe that *arvenses* are essential for the resilience of agroecosystems, in addition to their sociocultural significance for specific communities and their potential as the sources of food and medicine.

The term "quelites" has its origins in traditional Mexican agriculture. Outside Mexico, this word is rarely used. However, we propose the term to feature edible *arvenses*. Quelites are prevalent across the American continent, as well as globally, and diverse Latin American countries and Indigenous cultures employ varied terminology to describe them. Therefore, it appears essential to introduce a universally comprehensible term into academic discourse, free from negative biases associated with "weeds."

Our objective was not to produce a botanical or ethnobotanical catalog detailing all quelites and their uses, nor to conduct an agroecological analysis outlining the contributions of quelites to agroecosystems (although we acknowledge the necessity for such endeavors). The goal was to focus the attention of academics, students, activists, and decision-makers on this important issue. We are firmly convinced, and we substantiate this conviction with 12 examples that even those plants commonly perceived as troublesome "weeds" harbor substantial potential as nutritious plants. Moreover, these plants exhibit a remarkable adaptability to the soils and climates where they typically thrive abundantly. We support initiatives in favor of the conservation of TEK, recognizing the advanced and complex strategies to manage agrobiodiversity in traditional agriculture. As agroecologists, we do not classify plants as "weeds," but we see, first of all, their function in agroecosystems, the causes of their presence, and their potential use for humans and ecosystems.

With this article, we intend to contribute to the use of quelites, given their function in the fields and their potential as important sources of food. However, we have observed a certain rejection of the quelites in traditional communities, such as the Maya of the Yucatan. We relate this rejection, first of all, to the growing influence of Western diets in these communities. Currently, countermovements are discernible, particularly in urban environments in Mexico, where quelites are experiencing a reevaluation. They are increasingly recognized as essential ingredients that impart an authentic flavor to numerous Mexican dishes. On the other hand, we want to prevent quelites from becoming the next generation of superfoods that only satisfy a privileged urban clientele. The suggestion would be to delve into the information about its nutritional value, especially in traditional communities, who still possess the knowledge of managing quelites in their fields.

Outside of traditional communities, the greatest obstacle to the consumption and management of quelites remains the "clean field" doctrine in conventional agriculture, which simply prevents the presence of quelites in agroecosystems (except as occasional monocultures). Hence, we propose conducting agroecological studies focused on the field management of quelites, encompassing considerations such as their potential elimination when deemed necessary. We also want to bring the discourse about quelites to the world of nutrition and food systems. Quelites not only enrich traditional diets but can also be components of diets throughout the continent, especially considering the diversity of flavors provided and their nutritional value. Quelites represent an important potential to increase food security and food sovereignty.

Supplemental files

The supplemental files for this article can be found as follows:

La agrobiodiversidad más allá de los cultivos. Docx

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Conflicts of interest

We did not identify any conflicts of interest among all coauthors.

Author contributions

Concept and article design: RE.

Literature review and analysis, initial article draft writing: All authors.

Article review: RE, FDM, JPMP, LBO.

Approval of the final version of the article: All authors.

English version: RE, FDM, JPMP.

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