

THE CHILI PEPPER, AN AMERICAN FRUIT THAT GAVE FLAVOR TO THE WORLD

«Far more than a mere culinary ingredient, the chili pepper constitutes a living pillar of biocultural heritage and Mesoamerican identity.»

• *El chile, fruto americano que le dio sabor al mundo* •



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ABSTRACT

Chili peppers (*Capsicum* spp.) are among the American fruits with the greatest impact on global food culture. Domesticated thousands of years ago by Mesoamerican peoples, their selection and diversification gave rise to numerous varieties differing in shape, color, flavor, aroma, and pungency. Among domesticated species, *Capsicum annuum* stands out for its agricultural and culinary prominence, with chiltepin as its key wild ancestor. The diversity of Mexican chili peppers represents a vital biocultural heritage.

Keywords: *Capsicum*; chili pepper; capsaicin; Scoville scale; biocultural heritage.

1. A PUNGENT FRUIT

Few plants have exerted as transformative an impact on global human nutrition and gastronomy as the chili pepper. Originating in the Americas and domesticated thousands of years ago by indigenous Mesoamerican peoples, it is now an indispensable staple across all continents. The significance of this fruit lies not only in its exceptional culinary versatility across world cuisines, but also in the remarkable diversity of shapes, colors, aromas, flavors, and pungency levels developed through millennia of human selection (Hernández-Pérez et al., 2020).

While some varieties are completely mild or sweet, others attain extraordinary levels of pungency owing to capsaicin, the principal alkaloid responsible for heat. Breeding efforts over recent decades have yielded "superhot" cultivars exceeding two million Scoville Heat Units, although traditional landraces remain celebrated primarily for their complex bouquet, culinary harmony, and cultural heritage.

Beyond gastronomy, chili peppers have fulfilled essential medicinal, ceremonial, and ritual functions since pre-Columbian times, and continue to attract intensive pharmacological research due to bioactive compounds including capsaicinoids, carotenoids, and potent antioxidants (Hernández-Pérez et al., 2020).

2. ORIGIN, DOMESTICATION, AND GLOBAL DISPERSAL

Archaeological and phylogenetic evidence indicates that the genus *Capsicum* originated in the tropical and subtropical regions of the Americas. Microfossilized starch grains and macrobotanical remains unearthed across Mesoamerican and South American sites demonstrate that foraging human groups gathered and consumed wild peppers as early as 6,000 to 8,000 years ago (Perry et al., 2007; Kraft et al., 2014).

Of the more than thirty recognized wild and semi-domesticated species, five were independently domesticated by indigenous American peoples: *Capsicum annuum*, *C. chinense*, *C. frutescens*, *C. baccatum*, and *C. pubescens* (Ibiza et al., 2012). Among them, *Capsicum annuum* was domesticated primarily in Mesoamerica, subsequently becoming the most globally dispersed and economically dominant cultivated pepper on Earth.

Following transatlantic voyages in the late fifteenth century, chili peppers spread rapidly across Europe, Africa, and Asia via maritime trade corridors. In countries such as India, Thailand, China, Korea, and Italy, peppers became so thoroughly integrated into traditional culinary repertoires that many contemporary consumers are unaware of their strictly American origin.

«The chili pepper not only provides flavor and heat; it stands as a living testament to the agrobiodiversity of the Americas.»



Figure 1. Diversity of chili species in the genus *Capsicum*: *Capsicum annuum* (Jalapeño), *Capsicum chinense* (Habanero), *Capsicum frutescens* (Tabasco), *Capsicum baccatum* (Ají Amarillo), *Capsicum pubescens* (Rocoto).

3. CHILTEPIN: THE WILD ANCESTOR

Within the *Capsicum annuum* complex, the chiltepin (*Capsicum annuum* var. *glabriusculum*) holds paramount evolutionary and cultural significance. Recognized as the closest wild progenitor of domesticated chili peppers, it thrives spontaneously across arid scrublands, semi-arid plateaus, and dry tropical forests extending from the southwestern United States to northern South America (Kraft et al., 2014).

Its small, spherical fruits with piercing heat continue to be gathered by rural and indigenous communities, particularly in northwestern Mexico. Beyond economic value, chiltepin populations represent an indispensable genetic reservoir for agronomic breeding against biotic stresses, viral pathogens, and drought tolerance.

4. BOTANY OF THE CHILI PEPPER

Botanically, chili peppers belong to the Solanaceae family, alongside tomatoes, potatoes, and eggplants. The fruit is anatomically classified as a berry housing numerous seeds attached to a central interlocular tissue termed the placenta (Hernández-Pérez et al., 2020).

The distinctive pungency results from the enzymatic synthesis of capsaicinoids, a specialized class of lipophilic alkaloids accumulated almost exclusively in glandular epidermal cells of the placenta rather than the seeds themselves, correcting a widespread public misconception (González-Zamora et al., 2013). Capsaicin and dihydrocapsaicin jointly account for over 90% of total perceived heat.

5. ECOLOGY AND EVOLUTION OF PUNGENCY

From an evolutionary perspective, capsaicinoids did not arise to stimulate mammalian culinary appetites, but emerged as an adaptive chemical defense and directed seed-dispersal mechanism. Capsaicin serves as a potent deterrent against seed-crushing mammals whose digestive tracts grind and destroy viable embryos.

In stark contrast, birds lack the functional TRPV1 sensory receptor sensitive to capsaicin, enabling them to consume fruits unimpeded. By excreting undamaged seeds across long distances alongside nutrient-rich droppings, avian frugivores serve as the optimal mutualistic dispersers of the genus (Tewksbury & Nabhan, 2001). Furthermore, capsaicin acts as a targeted antimicrobial shield inhibiting predatory seed-infecting fungi such as *Fusarium*.

6. ETHNOBOTANY: FOOD, MEDICINE, AND CULTURE

In Mesoamerica, the chili pepper was not merely a seasoning but a nutritional cornerstone complementing maize and beans. It provided vital vitamins A and C, enhanced metabolic digestion of complex carbohydrates, and stimulated gastric secretions (Aguilar-Meléndez et al., 2021).

Colonial ethnohistorical records, such as the Florentine Codex compiled by Fray Bernardino de Sahagún, detail its therapeutic deployment against respiratory ailments, muscular pain, and digestive disorders, as well as its sacred status in ritual offerings and child-rearing disciplinary customs.

7. CHILI, CACAO, AND MESOAMERICAN RITUAL BEVERAGES

Among the most sophisticated culinary traditions of pre-Hispanic Mesoamerica was the sacred formulation combining chili peppers with cacao (*Theobroma cacao*). Diverging from modern sweetened chocolate, Maya and Mexica elites crafted bitter, frothy, energizing beverages by blending ground cacao beans with water, native vanilla, fragrant edible blossoms, fine nixtamalized corn dough, and pungent ground chilies (Almaraz-Valle et al., 2026). The heat tempered the rich natural lipids of cacao, providing invigorating psychoactive stimulation prized in religious observances and diplomatic summits.

8. THE WORLD'S MOST POPULAR CHILI

Despite hundreds of localized landraces, the jalapeño pepper (*Capsicum annuum*) has established itself as the single most cultivated, industrialized, and globally recognized pepper cultivar. Its worldwide triumph stems from ideal culinary balance: accessible moderate heat, thick succulent pericarp walls that withstand handling and canning, and a crisp, herbaceous flavor profile (Lozada et al., 2022).

Jalapeños are marketed fresh, pickled in escabeche, or smoke-dried via ancient Mesoamerican processing techniques that produce the celebrated chipotle pepper.

9. WHAT IS THE SCOVILLE SCALE?

To quantify chili heat, American pharmacologist Wilbur Scoville developed an organoleptic dilution methodology in 1912 that established Scoville Heat Units (SHU). The test determined the exact dilution ratio in sugar water required before a human tasting panel ceased detecting pungency (Scoville, 1912). Modern laboratories now measure capsaicinoid concentrations via high-performance liquid chromatography (HPLC), with results routinely converted to Scoville units for commercial clarity.

10. THE WORLD'S HOTTEST CHILIS

Recent decades witnessed intense agronomic rivalry to breed record-shattering cultivars. Ultra-pungent varieties including the Ghost Pepper (Bhut Jolokia), Trinidad Moruga Scorpion, and Carolina Reaper consistently surpass 1.5 million SHU, triggering profound neurochemical responses that engage thermal sensory receptors (González-Zamora et al., 2013).



Figure 2. Approximate heat levels of the world's hottest chili peppers on the Scoville scale (Carolina Reaper, Trinidad Moruga Scorpion, Bhut Jolokia / Ghost Pepper, Habanero).

11. WHERE DO MEXICAN CHILIS STAND IN THE PUNGENCY RANKING?

Contrasting Mexican traditional peppers with modern superhots underscores that authentic Mexican gastronomy never prioritized destructive extreme heat, but championed aromatic nuance and gastronomic balance. The hottest traditional pepper cultivated in Mexico is the habanero (*Capsicum chinense*), ranging from 100,000 to 350,000 SHU, honored with a protected Appellation of Origin in the Yucatan Peninsula.

Domestic landraces follow: chiltepin (50,000–100,000 SHU), serrano (10,000–25,000 SHU), jalapeño (2,500–8,000 SHU), and poblano (1,000–2,000 SHU). While not competing with extreme laboratory strains, Mexican varieties stand unmatched in organoleptic complexity.

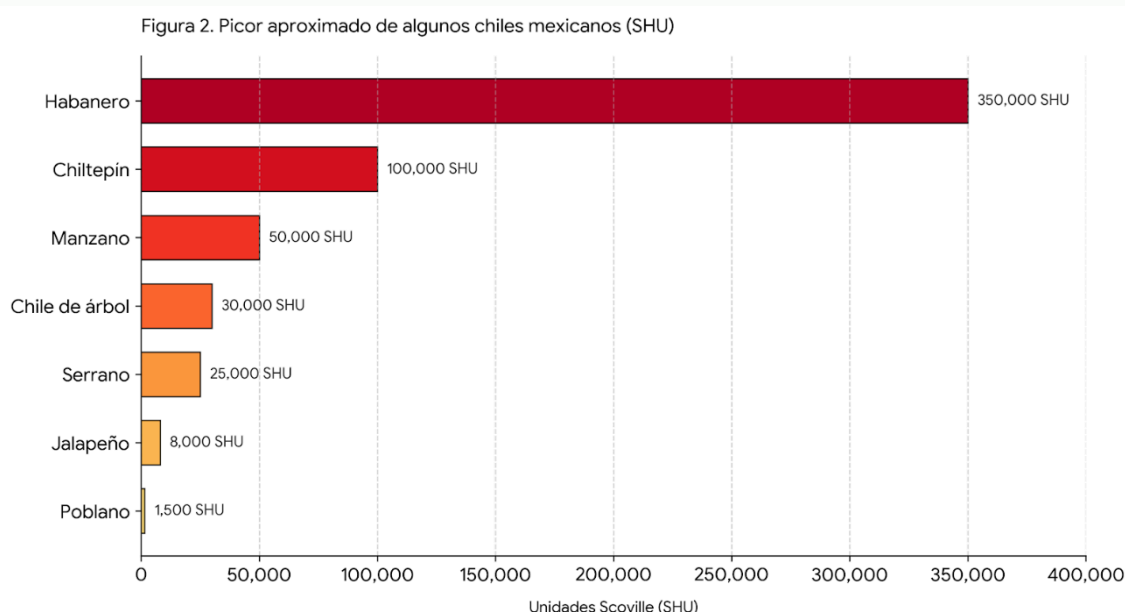


Figure 3. Approximate heat levels of Mexican chili peppers on the Scoville scale (Habanero: 350,000 SHU; Chiltepin: 100,000 SHU; Serrano: 25,000 SHU; Jalapeño: 8,000 SHU; Poblano: 2,000 SHU).

12. DIVERSITY OF MEXICAN CHILIS

Over millennia, Mesoamerican farmers selected cultivars tailored to distinct microclimates and culinary methods: jalapeño, serrano, poblano, guajillo, ancho, pasilla, chiltepin, habanero, manzano, and chile de árbol. Striking culinary dualities emerge between fresh and dehydrated states: the jalapeño becomes chipotle, while dried poblano becomes chile ancho (Lozada et al., 2022).

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13. COMMON MYTHS AND MISCONCEPTIONS

Chili peppers remain surrounded by persistent myths. Chief among them is the claim that seeds contain the greatest pungency; in truth, capsaicin biosynthesis concentrates in the internal placenta (González-Zamora et al., 2013). Nor does chili consumption inherently cause gastric ulceration: physiological tolerance depends on individual sensitivity, dosage, and frequency (Mandal et al., 2022), with moderate capsaicin even exerting cytoprotective effects on gastric mucosa.

14. CONCLUSIONS

The chili pepper represents one of the most emblematic embodiments of Mexican and American biocultural heritage. Its rich genetic diversity remains intrinsically intertwined with agronomic expertise, culinary innovations, and cultural traditions fostered over millennia.

Conserving native landraces in situ and ex situ safeguards critical genetic resources alongside the historical memory of farming communities. In this regard, the chili pepper is not merely an indispensable culinary ingredient recognized as intangible cultural heritage, but an enduring biological legacy built collectively throughout human history.

Transparency Declarations

Authors' Contributions (CRediT): Víctor Manuel Almaraz Valle: Conceptualization, Writing – original draft, Methodology. Rafael Robles Pérez: Writing – review & editing, Validation. Adriana Bautista San Juan: Writing – review & editing, Visualization. Carlos Eduardo Aguilar Castillo: Investigation, Resources.

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